BALUCHISTAN AGRIC EXTENSION & ADAPTIVE RESEARCH PROJECT

DIAGNOSTIC STUDY OF FARMING SYSTEMS IN BALUCHISTAN: KACHHI DISTRICT

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SUMMARY

The contents of this report are split up into three sections: the first describes the farming systems in Kachhi District and is followed by suggested groupings of farmers with similar situations and needs (Recommendation Domains). The third section provides suggestions for experiments and, to a lesser extent, demonstrations and extension to meet the needs of farmers in the district.

This report is the result of a CYMMIT style diagnostic survey of farming practices carried out in Spring 1987.

1. FARMING IN KACHHI DISTRICT

1.1 INTRODUCTION

The Kachhi Plain has an unenviable reputation as one of the hottest and driest places in Pakistan. The reliability of rainfall in the district is as poor as that of Nasirabad, but the whole area is "regularly" flooded by major rivers and hill torrents which flow out of upland Baluchistan.

The contribution that rainfall makes to agriculture is normally very limited, although in some years it may allow more timely planting or make a small but significant contribution to ratoon and sailaba crops at sensitive stages. A graph of the rainfall reliabilities for the three main subdivisions is presented in Annex A1. The basis of agriculture over most of the plain has changed little in the last one hundred years. Obvious exceptions to this observation are the large perennial irrigation diversions at Nari Headworks and Bolan Weir; a portion of Jhal Magsi Tehsil also receives water from the Kirther Canal.

Temperatures reach into the 50s in summer and are accompanied by strong seasonal winds. By contrast, although mean minimum temperatures rarely descend to zero, frosts do occur infrequently in the period from the end of November through to the end of January. These cold spells usually have a serious consequence for croppers. Mean monthly temperatures and mean maxima and minima are presented in Annex A2.

The ecologies found in the plain fall into the following subgroups:

a. Perennially irrigated areas in the midplain - Dhadar, environs of Sibi, and eastern Jhal Magsi.

b. Flood irrigated (sailaba) and a few rainfed areas (kushkaba) in the midplain - Lehri, Mithri, Belpat etc.

c. The western piedmont, which was historically the main irrigated portion of Kachhi, - Sanni, Shoran, Ghandava, and Jhal Magsi. This area also has considerable sailaba and kushkaba cultivation.

Infrastructure in Kachhi is poorly developed and the majority of villages and small towns are reached by dirt roads which are rendered impassable in the flood seasons. Tribal life remains fundamental to the people, but although there are powerful sardars, land ownership is more common than in neighbouring Nasirabad. Tribal chiefs may be wealthy, but merely being a landowner does not necessarily confer any material advantage in the harsh conditions of the plain.

1.2 IRRIGATION SYSTEMS

1.2.1 General remarks

The farming systems of the district are relatively simple, and well adapted to the environment. The flood water farming practices are little changed from a century ago, although attempts have been made to harness "modern" technology to diverting spate water. Irrigated cropping has become more extensive due to construction of two weirs at Bolan and Nari, and more recently due to electrification, which allows water to be pumped from shallow surface wells and the major rivers (in winter).

Both the small area of irrigated crops and the extensive flood water spreading system are integral parts of this infrastructure.

1.2.2 Perennial irrigation

Perennial irrigation has been carried out for centuries along the western piedmont from Sanni-Shoran to Ghandava and down to Jahl Magsi. Water was pumped from shallow wells using Persian wheels, and there are still many more animal powered wells than motorised ones in use today. In Shoran there are 16 animal powered wells compared to 3 diesel powered ones. In these areas the cost and difficulty of access mean that water costs can be very high. The water table depth varies from 15 to 25m and costs of 270 Rs per hectare (110 Rs/a) are quoted per 100mm irrigation by farmers. In these cases, irrigation must inevitably be suboptimal for high as well as low value crops.

The villages of the western strip have therefore depended on a network of some 30-35 springs and diversions whose sources often lie more than 5km upslope in the mountains. There has been some confusion in describing these sources as it appears that there are only a few true karezes, the remainder being springs. The water shares were originally determined in proportion to the labour or cash given to construct the waterways; subdivision of water shares has happened since as family land holdings have fragmented. Water shares can be sold, mortgaged or traded, but the agreement of the other shareholders is often required. The water managers (Reis/Arbab) now use watches to time the distribution of water; in the past there was an amazingly accurate system of timing shares by the position of the sun (by day) and different constellations by night.

Near to Chandava itself, there are many channels leading water from the Mula and Sukleji rivers. Every year farmers construct temporary weirs to divert the water from the main channel, and these normally do not survive the August floods. Many channels were lined by the Irrigation Department in the 1960's but there has been little further official involvement as proposals for major works were rejected by some Sardars who wished to restrain Government influence.

There is a "Reis" for each community and as tribal identities are particularly strong in this area, each tribe within a village usually has its own watercourse.

For both well and spring supplies, the flows are at their lowest in June and July. The supply over the winter months is the greatest and accounts for the predominance of wheat, and cucurbit production. Severe interruptions in water delivery from river diversions occur after floods as it can take a long time to rebuild a weir and train the perennial water back to it.

A newer system of pumping has been introduced by the Nawab Raisani; diesel and, more recently, electric powered centrifugal pumps are employed to pump water from the Nari river as long as there is sufficient flow. Water is usually available from October through to the end of April. Pumps of 20-40kW are used and are exclusively administered by the naibs and reis of the Raisani family for tenants. A total of about 2000 Ha is claimed to be irrigated, principally on the eastern bank of the Nari at Mithri. The pumps are run for 24 hours a day and incur electricity charges amounting to 24,000 Rs. per year. A 40kw pump installation may cost around 40,000 Rs. but this can be paid off in one year by the production from 50 Ha. of melons. One such pump might service between 100 and 150 Ha. of melons.

Before it was washed out in August 1986, the Bolan weir supplied water to 4,850 Ha. on the left and right hand banks of the river (approx. 80 cusecs). No water charges are paid by the farmers and the distribution on the lefthand bank is administered by the Irrigation Department (Dhadar, and Mushkaf distributories) . The distribution on the right
appears to be organised on traditional
of zamindars, although the irrigat
the head reach of the main channel.

The area irrigated by water from the
part of Kachhi adjacent to Sibi, and
is principally a wheat and sorghum fod
by variability in supply at the tail o

1.2.3 Sailaba

The Gandha system dates back many centuries and has provided the livelihood of the farmers and tenants in the plain. Large diversion and impounding bunds were constructed across major floodways and their overspill channels. These bunds were communally made and organised by the Sardars, Reis and Arbabs of the locality; where possible "permanent" earth embankments were made but they were frequently washed out. Permanent bunds were sited where floodwater could escape down tributaries which flowed down to the Sind without inundating any land in Kachhi. A second system of bunds was also used; these were made annually and breached when farmers estimated that sufficient water had been infiltrated over the locality. This system also ensured some equality of distribution for downstream cultivators.

The Irrigation Department has built many concrete structures on the sites of important Gandhas; many of these have silted up so badly that they no longer work effectively (viz Ghazi, and Mangi) or they bias water distribution to one section of the community. At Mithri, some flood water passes down the distribution channels on the right hand bank as long as farmers do some desilting each year. A division weir at Lehri, first constructed in 1957-8 now diverts the lion's share of spate flows to cultivators with rights to only one third of the flow; this has happened because of heavy silting on the inside bend portion of the weir.

The old system of building and breaching bunds has recently been revived at Haji Shah using up to 200 oxen for a month and a half to build the earth embankment. The Pak-German Self Help project has constructed a very successful ring dam on the site of an old Gandha at Jalal Khan, near Bhag. This earth bund has survived four flood seasons to date and is very cost effective in comparison to the concrete structures made elsewhere. Even when big engineering works are well sited, the siltation problem means that their lifespan will always be limited. It is evident that lower cost solutions such as those at Jalal Khan are more desirable and that a resuscitation of traditional Gandha practices, using swifter techniques (such as bulldozers for earth moving and compaction) are very appropriate.

1.3 CROP PATTERN

Detailed crop calendars for all important crops are given Annexes B1-2. In general, the irrigated cultivation of cucurbits/vegetables, sorghum and wheat takes place on different land, each following its own rotational pattern.

1. Wheat (barley or oats)-fallow-wheat-fallow
2. Cucurbits (vegetables)-fallow-cucurbits-fallow
3. Fallow-sorghum-fallow-sorghum

Cropping intensity for irrigated areas runs at between 90 and 120 per cent depending on the small amount of sequential cropping of wheat and April planted fodder sorghum.

The basis of flood irrigated agriculture is a mixed crop of sorghum, mung bean and moth bean (Phaseolus aconitifolius). This is sown after the summer rains in July, August and September; the wheat area is small by comparison. Spring plantings of sorghum and melons are made whenever possible and rapeseed sown after late summer rains is important in the western region and in Lehri. Cropping intensity is strongly determined by the extent, size and number of floods and these factors vary considerably from year to year. Farmers say that there is always a minimum amount of floodwater which allows them to bring some crop through to maturity. Overall cropping intensity may typically be between 30 and 40% of cultivable land; however, the intensity of production on land that is well and regularly watered may reach 150-180% when a sorghum-mung-moth crop and an early sorghum crop are grown back to back.

1.3.1 Crops grown under perennial irrigation

Wheat for subsistence is usually the priority crop in the irrigated areas, although some farmers in the Dhadar area grow sorghum fodder for the Quetta market as their principal crop. The most important cash crop is melon, followed by tomato; water melons, squashes and gourds account for only about 10-15% of the area devoted to melons.

1.3.2 Wheat

Wheat is grown as a subsistence crop under liberal irrigation where possible. It is rarely cut for fodder (Khasil) due to the importance of grain production. Although wheat may be thinned in January-February the proportion used for fodder rarely exceeds 10-15%. Throughout the district barley is grown specifically as a substitute for Khasil but in the Dhadar area oats have been widely introduced for fodder.

In the Gandawa area wheat is given 3-4 irrigations only in an attempt to augment the total cropped area in preference to maximising yields.

Under sailaba conditions wheat is sown only when there are late floods, particularly in late August and September. The

ground is left some twenty days to dry out before sowing in early October. If the weather has been hotter than usual and the soil surface has dried out, the land is cultivated once with a tractor drawn cultivator or traditional bullock plough; wheat is then sown by "nali"- using a drop tube and local plough to drill the seed into moist soil in rows.

Usually the farmers broadcast onto moist soil and then plough in the seed using either animal or tractor drawn ploughs. This method is preferred as it is less labour intensive.

The old established practice of selecting sandy clay-loams for wheat production persists as these soils are recognized as having the best moisture retention properties. Wheat is normally only sown after the plot has been inundated three times.

1.3.3 Sorghum

Irrigated sorghum has a high value when grown as fodder for the Quetta market. Seed is broadcast at relatively high seed rates in April and provides fodder from late May through to July.

The main crop of sorghum is sown as soon as possible after the first summer floods, which means after 10-15 days in July and early August. It is a matter of individual's preference as to whether sorghum is mixed with pulse seeds and broadcast or whether it is drilled by local plough following the broadcast of pulses. When all seeds are broadcast together they are ploughed in by tractor or bullocks. Where farmers have ready access to tractors and are prepared to pay the hire charges, the combined method is preferred. It is rare for these crops to receive a second watering; farmers prefer to expand the acreage with subsequent stormwater.

Sorghum stubbles from the summer plantings are deliberately left in the field to ratoon if spring rains permit. When spring floods are sufficient, well watered stubbles are ploughed in and new seed is broadcast or drilled. Traditionally, ratoon crops were wilted and then fed as fodder; nowadays, most is fed, chopped with sorghum straw, but some is taken through to grain if farmers think that residual moisture after rains and floods is sufficient.

1.3.4 Melons and other cucurbits

Melon cultivation is reported as being of poor quality in the Kachhi Gazetteer of 1904; since that time it has become a major crop under perennial and floodwater and recently on

residual moisture after irrigation. During the last ten years the acreage has expanded considerably. Watermelons and other cucurbits are less widely grown due to restricted markets.

Melons are generally grown on raised beds under irrigation and are watered very liberally in the Dhadar area where water is virtually "free". By contrast melons grown on pumped water are produced under a much stricter regime.

Residual moisture cropping is practiced in the Mithri area because water is only available in the Nari river until the end of April. Normally 2-3 irrigations are given between planting in February and March. Productivity appears to be good in this system as melons are very good exploiters of soil moisture and develop extensive root systems. The quality of these melons also appears to be good, but they do not have the physical size of their irrigated cousins.

This residual moisture system parallels the traditional flood water cultivation of melons on one February or March flooding. Farmers adjacent to the irrigated areas will not plant melons if the rains arrive later than 28 February as they believe that they cannot compete in the market: they point out that late plantings are less productive because the heat of May and June affects the plant at an earlier stage of growth. However, in Lehri, Bhag, and Shoran the local market is sufficiently isolated and strong to allow planting into early April.

1.3.5 Tomatoes

Tomatoes (and Bhang) are the most specialised crop(s) grown in the area. Again, there is considerable variation in planting time depending on the irrigation supply and market situation. In Kot Ralsani/Merghar production is aimed at the late January-early February market in Quetta where prices may be double those in March. In nearby Mushkaf, transplanting only takes place in late January/February; this is also true of tomato production in the more cut-off localities. There may be some value in the end of season market (to early May) before the hill produced tomatoes hit the market. There are apparently no farmers producing specifically for this niche.

1.3.6 Minor Crops

Citrus and mango are grown in the Dhadar area and in the gardens of Sardars, but as yet are not important commercial crops. Vegetables such as spinach, turnip, radish, brinjal (egg plant) and lady's finger are grown on small (0.25-0.5 Ha.) irrigated plots throughout the district: the produce is normally consumed on the farm or marketed locally.

1.3.7 Fodders

1.3.7.1 General Remarks

Livestock are a critical component of the farming system in Kachhi. As a consequence, fodders are of great importance; the choice of fodders is not immediately obvious. Sorghum straw is the major source of fodder in all but the fully irrigated areas (Dhadar, and adjacent to Sibi). The production is considered sufficient in all years and some farmers state that there is even too much. When possible sorghum straw is supplemented with pulse haulm which still contains a proportion of mung and moth seed after threshing. Other supplements include fresh cut sorghum in May and June and again in October-December, and rape cut fresh in November through to January. Oats and barley are common green fodders in the irrigated area and cotton seed waste is sometimes imported from Sind.

Rape fodder is grown on the same lands as wheat and is usually given two inundations before sowing; in Lehri it is also grown in the deep bundats that have impounded more than a meter of silt. The seed rates used for fodder are much greater than for oilseed production; the crop is not so much harvested as thinned so that oil can also be obtained at the end of the season.

In the irrigated areas there is a greater reliance on wheat straw, whole barley and oats. There is also some lucerne grown near the major towns but it represents a tiny fraction of the cropped acreage.

1.3.7.2 Oats

Oats for fodder were introduced by Nawab Raisani and are mainly grown in the Kot Raisani / Merghar area. This year other growers in the Dhadar area are also growing oats but as yet the practice has not spread further south. Oats are now being consumed locally but were originally grown for the Quetta market. Yields of green matter are similar to those for wheat and barley at c. 20,000 kg/ha. After initial scepticism, farmers now believe that the fodder quality of oats surpasses wheat and barley. Following the rains this March much lodging could be observed, and it may be advantageous to introduce slightly shorter varieties if the crop area increases. None of the farmers interviewed knew where the oat seed originally came from.

1.3.8 Fallow

A significant difference between the agriculture at the turn

of the century and that of today is found in fallow practices. Within the irrigated and established bundat areas there was a two year fallow period after each productive year. This practice is no longer found: the only obvious fallow system employed is seasonal. For the most part, the same crops are now grown on the same land year after year. There is mounting evidence of bacterial and other soil borne infection in melons due to 6-7 years cropping without rotation.

As seed born diseases such as sorghum smut and verticillium and bacterial wilts of pulses are common in sailaba conditions, some rotation and pure seed supply is called for. Rising populations and the nature of the flood spreading pattern seem to militate against improving rotational practice.

A rare exception to the non-use of fallow was noted in sailaba cultivation at Haji Shah, where land becomes fallow after four years of cropping. The reason for this may be that the soil "specialist" or arbab is still an active tradition there.

1.4 VARIETIES

1.4.1 General observations

In general, there is very little use of "improved" varieties in this district. Under sailaba conditions nothing has so far been introduced that competes with the local varieties. This is probably due to the fact that all introductions have been selected under irrigated conditions.

The spectrum of local varieties grown has reduced since the turn of the century when many were reported in the Gazetteer.

There are considerable possibilities for selection and screening of the local gene pool, and this could be a priority for the Adaptive Research programme in conjunction with a applied research institutions.

1.4.2 Wheat

Under irrigation the most commonly mentioned improved variety is Mexipak which has been multiplied on farms for many years; it has also been tried by farmers under sallaba conditions and been found to be a poor performer. Pavan and Pak 81 can be found in the irrigated lands but are not widespread; most farmers we talked to were unaware of the names of the improved varieties in use.

Zarghoon was obtained from the Department by Nawab Raisani and multiplied before distribution to tenants; unfortunately we met no tenants who were aware that they might have grown this variety.

In Gandawa a great number of varieties are being grown which are obtained from the Department's seed farm and from farmers' relatives who are tenants in Nasirabad. Thus Mexipak cultivars, 711, 332, Pawan, Pak81 and Sonnalika can be found. The local ("Farmi") has been completely displaced in some areas and the highly localised occurrence of each choice is remarkable. The most common is "Mexi" which is appreciated for its taste, yield and lower irrigation requirement compared to the newer rust resistant varieties.

The most commonly identified local varieties are red and white; both are long strawed and lodge if "high" doses (÷50 kg/lla) are applied. No preference for either could be determined by the interviewing staff.

1.4.3 Melons

One variety of melon was mentioned consistently by farmers; this has become known as Raisani and is said to be the result of an imported American cultivar crossed with older "local" varieties, which themselves were introductions from India. Japanese watermelon seed is bought in Quetta and is preferred to Punjabi seed: the variety normally grown is "Sugar Baby" and is treated with thiram.

1.4.4 Sorghum

Although four varieties of sorghum were noted in the gazetteer of 1904, there is in principal only one variety in use today; this is known variously as "pump", "toori" or "baghi". It is a dual purpose fodder and grain cultivar, which has a very sweet central meristem that is eaten like sugar cane. It appears that this is an outbreeding variety, as it produces grains of various colours; for seed, the best white-grained heads are selected and cut by the farmers. This is not a universal practice, but occurs where traditional practices and village organisation are still strong and not compromised by indebtedness. When all grain is sold to traders and seeds are bought as required (viz Bagh area), farmers are less selective.

In Gandawa, three varieties are known by name and are called Acheri, Tor and Toori. Both Acheri and Toori are upright headed, white grained sorghums, but Toori is the better overall performer and fodder producer and can be recognised by the green midribs of its leaves. Tor produces a dusty

coloured grain and has a characteristic drooping panicle with tightly held grains.

There may be good possibilities for screening this material and developing truer breeding lines.

The "Baghdar" variety mentioned in the literature was not usually mentioned by name in Kachhi. Farmers in Gandawa say that it is a Sindhi variety and has never been grown in their area as it does not perform as well as the locals.

1.4.5 Oats

The original source of the oat cultivars grown is unknown; it is a long strawed variety with a tendency to lodge; this was particularly evident after the rains late March. It may be worth screening shorter strawed varieties from elsewhere which are less prone to lodging.

1.4.6 Pulses and oilseeds

A single local variety of mung and moth are grown; there is a similar lack of diversity with oilseeds. Although the yield potential of these cultivars can be good, the practice of using one's own seed means that seedborne diseases are common and sometimes devastating. Sources of cheap pure seed are required, and this may be more easily achieved with introduced cultivars.

1.5 YIELD

Crop	Lowest	Highest	Typical
	kg/Ha		
Wheat(irrigated)	700	2770	1900
(sailaba)	450	1200	600
Sorghum fodder	29600	44500	33000
Sorghum in mix	700	1980	1000
Mung + moth	200	650	395
Rape	150	495	400

Table 1

NB. These figures are rounded from maunds per acre (1 maund = 40Kg). Total crop failure is always a possibility in Sailaba cultivation but has been ommitted from the table for clarity.

Reliable data on vegetable yields could not be obtained in the time available as picking is continuous and although commission agents' invoices are available they are not indexed to specific plots.

1.6. SEED RATES

1.6.1 Seed rates

Commonly used seed rates and the recommended values are presented below:

Crop.	Seed Rate used (kg/ha)	Recommended rate (kg/ha)
IRRIGATED		
Sorghum fodder	50	37- 75
Wheat	90	110-125
Melon	1- 2.5	2- 3
Turnip	4- 5	7- 10
Spinach	15	25- 37
Radish	7-10	7- 10
Lucerne	12	15
SAILABA		
Sorghum	25	20- 25
Mung/Moth each	12-15	-
Mustard fodder	12-15	12
Millet	37-50	112- 15

Table 2

Seed mixes of sorghum and pulses have many variations but commonly include the following (Kg/Ha):

	Sorghum	Mung	Moth	Sesamum
a.	25	10	5	2.5
b.	30	15	15	-

Table 3

1.6.2 Sources of seed

Most cereal seeds are multiplied on farm; introduced varieties obtained from the Department or friends are usually multiplied on farm by the progressive farmers and are then disseminated to others. The Government seed farm at Gandawa is a major source of seed in the immediate neighbourhood as many farmers are also tenants of the Department.

Vegetable seeds are normally bought in the Quetta market each season. However, most melon seed is selected on farm from "best" quality specimens. In Gandawa, vegetable seeds are

sold to shopkeepers and then resold back to farmers with only occasional "injections" of material from outside.

Seeds are often bought in sailaba areas; the reason given by farmers is that the viability of sorghum, mung and moth is poor if stored for two years or more and there may be years with insufficient floodwater for cultivation. In addition, farmers are often under pressure to repay as much as possible to Hindu traders and therefore sell all that they have. The irony of this is that seed often costs considerably more than the normal grain price.

A summary of seed prices is given below:

Item	Rupees	Unit	Rupees per hectare
Mung & moth	250	40 kg	90
Wheat	120	40 kg	100-120
Sorghum	60-70	40 kg	40 (80 for fodder)
Rape/mustard	120-130	40 kg	36
Melon	35	1 kg	50-85
Tomato	400	1 kg	44

Table 4

1.7. INPUT USE

1.7.1 Fertiliser

Fertilizer use is very variable in Kachhi and mainly reflects the credit availability of farmers and the policy of landlords. Small owner occupiers use the least quantities on wheat but if they are producing vegetables, may u- substantial quantities of nitrogen and phosphate. irrigation supplies are limited, farmers restri fertiliser use on wheat since the number of required increases. The potential yield of responsive varieties is never realised f Vegetable producers who have bee fertilisers by landlords make lar- is provided.

Only one instance of potas use it it improve colour o melons: the rate is very sma

CROP	FERTILIZER (Nut kg/Ha)	
	N	P_2O_5
Wheat	26	19
	114	0
	158	114
Melon	0	0
	76	57
	158	114
Sorghum	0	0
Sorghum fodder	158	114
Vegetables	0	0
	158	114
Tomato	158	114

Table 5

Applications are normally made as whole bags of urea or DAP per acre.

1.7.2 Pests and pesticides

The major pests of sailaba crops can have a surprisingly big impact on production. The main pests of sorghum are stalk borer and shoot fly and smuts may also infect about 10-15% of the standing crop. The pulse crop mixed with the sorghum is sometimes destroyed by virus diseases (mosaic and yellows) and at the moment there is no economic way of controlling the aphids which infect the crop.

Wheat suffers from severe yellow rust once in three to four years but resistant varieties have still to gain widespread acceptance.

Vegetables are host to many insect pests, the most economically damaging being fruit borer, cutworm and aphids on tomatoes and pumpkin beetle, fruitfly and cutworms on cucurbits. Soil and seed born blights and wilts are increasing as vegetables are normally grown on the same plots year after year.

Pesticide use is generally confined to vegetables and the choice of chemicals remains limited to BHC and Sevin dusts in most places. Benlate, Dimecron and malathion are available at Dhadar. The Department is the sole supplier of chemicals and provides most of the spraying equipment.

Rodents are a major problem in Sailaba systems as they tunnel into the bundats and weaken them so that they break during the floods. Zinc phosphide is used with limited success but

most farmers find it difficult to buy enough to achieve good control; apparently it has a very noticeable smell and the baits put down are often ignored.

Along the western border of Kachhi, big animals such as pigs and porcupines damage crops and are hunted with dogs and rifles. Birds also do much damage but are difficult to control. Flintlock shotguns are still made near Gandawa for all forms of hunting.

1.8 IRRIGATION MANAGEMENT

1.8.1. Management of perennial water

1.8.1.1 Farmers' priorities

Farmers priorities for watering crops are indicated below in descending order:

	Irrigated	Sailaba
1.	Tomato	1.Sorghum-pulses
2.	Melon	2.Mustard
3.	Sorghum fodder	3.Wheat
3.	Wheat	
3.	Vegetables	

Table 6

1.8.1.2 Irrigation intervals

The typical numbers of irrigations are given as follows:

Crop	Typical number of irrigations	
Wheat	4	(3-6)
Sorghum fodder	5	
Oats	7	
Melons	15	
Vegetables	8-15	

Table 7

Sailaba sorghum on its own may receive a second watering but if mixed with pulses this rarely happens as mung beans are damaged by the inundation and subsequent disease.

1.8.1.3 Depth of irrigation

Where perennial water is free or plentiful, farmers try to apply a standing depth of 150mm; however, the expense of pumping from wells normally limits this to 100mm maximum.

Under sailaba conditions as much as one meter of water may be impounded before a bund is closed off from incoming floodwater. The farmers try to impound a minimum of 300mm over the whole bundat; the total depth impounded depends on the size slope and uneveness of the individual plot.

1.8.2 Management of flood water

When flood water is limited the land is inspected after the water has receded. If the depth of wetting is thought to be insufficient crops are only sown in depressions or adjacent to unbreached bunds. Before or during floods, farmers make distribution channels to lead flood water to specific areas for cultivation; this practice is more common near the foothills when farmers desire to move water further down into the valley bottom. Bundats are filled and then closed off before the next one in a series is filled.

In Gandha (or Irrigation Department schemes) permanent distribution channels are dug and maintained. Quite complex systems of field channels have evolved in some areas (viz Mushkaf) and water rights are clearly understood. Two main practices are followed; the most common system allows those at the head of a system to water all their land before allowing water to pass to lower cultivators. This warabandi ("turn") proceeds down the distribution network as long as the flood lasts. When the next flood comes, the turn starts from the last spot to be inundated. This process continues for as many floods as necessary to reach and satisfy the tail enders before the right to irrigate returns to the upstream growers. Farmers with land at various points along the network have the right to choose whether to re-irrigate land lying up the system, if they so wish. It is more normal to irrigate new land for sorghum and pulses; late floods in August and September may be diverted onto the same land 2-3 times for rape and wheat respectively.

The second practice in use allows the upland cultivators first chance at the water from every flood event and is therefore much less equitable. In both cases water is proportionally distributed down a number of main channels at the same time. In some cases a particular channel has first priority and a turn system from distributory to distributory may be practiced.

Few farmers mentioned that siltation in fields in the midplain was causing command problems for irrigation; it must be assumed that most of the silt born by the Nari and Bolan is arrested by the diversion structures or deposited in the major channels.

1.9. SOILS AND SOIL MANAGEMENT

1.9.1.1 General points

Kachhi is blessed with deep relatively fertile alluvial soils ranging from fine sandy loams to sandy clays. The predominant soil type is loam-clay loam. Soil management is critical to agriculture under flood irrigation and there is an old and well developed tradition of such practices.

Soils are classified by texture and salinity using the following expressions:

Kallar.....salt affected soil
Chukni.....clays and loamy clays
Kauri.....loam to clay loam
Rehti.....sandy soils

The medium textured soils are preferred and millet, rapeseed and sesamum are reserved for the lighter soils where possible.

1.9.1.2 The "Arbab"

The Arbab is both a position in the tribal heirarchy and the job of soil specialist. He is responsible for all earthworks, repairs, classification of soil types for cropping, and categorisation of water quality. The title is hereditary, and the son works as apprentice and then partner until his fathers death. In some areas this tradition has died out and with it the detailed knowledge of soil properties, but it remains in the more feudal or traditional communities.

1.9.2 Drainage and salinity

Drainage problems are very rare in Kachhi, if they exist at all, but there is widespread salinity. Most farmers

know the salt affected lands and avoid cropping them. The quality of surface irrigation water is generally good but the groundwater in the district is quite saline in many places.

1.9.3 Measurements of conductivity

Fewer measurements of the conductivity of irrigation water were taken by the study team than in other Districts because of the predominance of sailaba agriculture. Values of 950 micro mhos/cm were recorded for water from the Bolan Weir which is acceptable for all forms of agriculture. Surface water from the Sukleji and Nula rivers is slightly better at 750 micromhos/cm in contrast to shallow well water conductivities of 2000-2500 along the western piedmont.

1.9.4 Bundats

Bundats are embankments which bound a field and allow floodwater to be stored and infiltrated. The height of bunds varies according to their proximity to alluvial fans and hills. Large bundats, typically 1.5-2 meters high are made on steeper sloping land on the foothills at the edge of the plain. There are two reasons given for making them so large: mechanical strength to resist being washed away and the capacity to impound silt that is brought with the floodwater. The annual silt deposition can be as much as 30cm and the farmers hope to create level fields with fertile, deep soils.

In the open plain, alongside the river system bundats may be as little as 30cm high; as the land slopes are about 1:2000, sufficient depth of water can be impounded to wet c. 1.5 meters of soil. However, these bunds are more fragile and are often swept away in floods, with the result that only 30-50cm of soil is wetted to field capacity. Limited infiltration occurs due to inherently low infiltration rates in the capping loam soils. Uncultivated soils have an impermeable cap and even cracked or cultivated soils "seal" over after the first 25-30mm have infiltrated. Thus water needs to be impounded for 24 hours or more.

Farmers are aware of this problem and it is the Arbab's job to check bund condition and organise repairs. Tenants are usually required to carry out the work themselves. Rat holes are considered to be a major cause of bund instability and hence one of the few pesticides in demand is zinc phosphate for rat control. The other causes are insufficient compaction and lack of escapes to allow excess floodwater to flow to the next bundat. The bunds are normally made in dry soils with bullock

drawn scrapers and receive little compaction. Even when tractors with blades are used, little attempt is made to compress the soil.

One of the most frequently voiced desires of zamindars and tenants was for bulldozers for bundat and Gandha making.

1.10. LIVESTOCK

Animal holdings are an important and sensitive topic; livestock provide the fundamental security and main source of income in flood farming communities. People interviewed were obviously reluctant to divulge the number and type of livestock that they own. Most crops grown must have a dual fodder and grain value.

1.10.1 Draft animals

All tenants and most farmers in sailaba areas have at least one bullock pair for all cultivation work. Most farmers who have tractors also own bullocks if they have both irrigated and sailaba land; the ability to drill seed deep into the soil is very important in sailaba fields which have dried out at the surface. This task can only be done at the moment if a local bullock drawn plough is used.

It is rare for farmers to own more than one bullock pair and if extra cultivation or earth moving must be done quickly, farmers share their animals with each other.

Camels are extensively used as pack animals but most of the transport of harvested crops is done by ox and cart.

1.10.2 Other livestock

One or two cows are usually kept to provide milk for each family but the main source of income and meat is from sheep and goats. Farmers were particularly coy about the number of sheep and goats they own; the range given started in the order of 4-6 and went up to 60-100. As the same farmers reckoned to sell a minimum of 10-12 animals per year and eat a similar number, holdings should often be in the 15-25 range. At Haji Shah, the livestock holding is regulated by the landlord. By tradition each Arbab is responsible for six tenants; each tenant may own draft and milking animals and eight to ten sheep or goats. The Arbab himself may own 25 sheep and goats and it is assumed that the Reis who supervises the arbabs has proportionately more.

In Jalal Khan one of the immediate benefits of the successful ring dam is that livestock numbers have increased considerably. Average prices for sheep are around 300 Rs. per head.

There is a tradition of communal grazing and in the irrigated areas there are herders who are paid 5 Rs per large animal and 1.5-2 Rs per small animal per month. These men must be responsible for protection of standing crops and grazing of stubbles throughout the village. In Kot Raisani and the Gandawa area, these herders are known as "Gowal".

1.10.3 Manures

FYM is primarily a fuel and building material and is rarely used on the land in sailaba because farmers believe in the inherent fertility of their soils. It is however widely used in vegetable production, particularly for tomatoes. Farmers main reasons for applying FYM seem to relate to improvement of soil structure rather than the supply nutrients.

The Gandawa area contains farmers who use FYM on sailaba and khushkaba land in addition to the irrigated wheat lands. However, there are other villages nearby where FYM is actually thrown away and not used for anything at all. The reasons for such extreme variations in practice between neighbouring villages could not be determined.

1.11. LAND TENURE

1.11.1 General observations

Kachhi is still fundamentally a feudal district and is organised by tribe, sub-tribe and caste. However, due to the difficulty of cultivating large areas there are considerable numbers of owner occupiers who may also be tenants. Apart from major landlords such as Nawab Raisani, Sardar Domki and the Magsi family it is rare to find landlords with more than 1000 acres. Cultivated areas are often less than 40% of the land owned. Typical tenant holdings are of 30-50 acres although tenants who are also farm managers (Naibs) for landlords may have as much as 500 acres. Cropped areas are again typically 30-40% of the total holding.

1.11.2 Share cropping

The normal tenancy arrangement in sailaba is that the landlord receives one third of all the grain and one tenth or none of the straws and residues. All inputs, tractor hire charges, seed costs etc. are born by the

tenant who keeps two thirds of the grain and the bulk of the straw.

Under irrigation the variable costs and produce including straws and residues are shared on a half and half basis. Costs of water are an exception to this; at Mithri the landlord pays all costs associated with the irrigation supply. By contrast, at Sanni and Shoran, tenants must buy water pumped from wells or water sold by shareholders in a spring or karez. These costs are in addition to their own or their landlords right to water.

1.11.3 Hired labour

The most labour intensive jobs in sailaba are Gandha construction, seeding after summer floods and sorghum-pulse harvesting. By contrast in irrigated areas the labour peaks occur where vegetable and melon operations overlap with sorghum and wheat harvesting; for tomato production there is a constant overlap from January through to April and at transplanting in October-November. There is also some competition for labour in December-January when sailaba sorghum must be headed and the stalks cut for fodder before Palezat can be prepared and sown.

In areas where there are more than one tribe, labour is usually hired. Near to Dhadar the labour rate is 25-30 Rs. per day, but is 5-10 Rs. less elsewhere. A system of pooled labour is used when there is a community composed of one tribe; for operations such as land preparation, transplanting, and stringing up in tomatoes, informal groups of producers assist each other. An individual is bound to repay his assistants with his own time, but he can do this when it suits him.

1.12. FARM POWER

1.12.1 Cultivations

Many large landlords and bigger tenants own tractors, but use of tractors is not as widespread as farmers desire due to the hire cost. Rates vary from 60-75 Rs. per hour (90-120Rs./acre), and this is too much for most Sailaba tenants' cash availability. Mechanised cultivation is recognized as being an important advantage in timely cultivation after floods. Farmers can never do more than one ploughing in sailaba and the resulting seedbed is often too cloddy for good, even germination and establishment.

In melon production, primary cultivations are often done by tractor using tine cultivators; two passes followed by a planking is the norm. All subsequent ridging, bund

and bed making operations are done by hand. Vegetables are usually grown on small plots of 0.5-1 acre; in these instances most cultivation is done by animals or men.

1.12.2 Post harvest operations

Threshing, hulling sorghum, and milling wheat are traditionally done using animal power. As electricity is supplied to villages, it seems common for landlords or traders to invest in machines for hulling and milling. It is rare to find tractors used for threshing on the traditional threshing floors; pulses and oilseeds are beaten by hand to release their seeds.

1.12.3 Storage

Women are responsible for storage of grain in earth pots (Gundis) and for cleaning it. An interesting practice of adding chopped "Sri" (Albizzia lebbek) leaves to stored grains for protection against insects is used in some villages.

1.13. DECISION MAKING

Tenants make all decisions relating to crop type, area sown, timing of operations etc. in sailaba culture. Landlords determine crop selection and management practice in the irrigated areas, particularly where pumped irrigation is paid for by them.

Owner occupiers who primarily produce cash crops are very much influenced by the availability of commission agent credit for a specific enterprise

1.14. CREDIT AND MARKETS

1.14.1 Credit

Access to credit in the Kachhi plain presents great difficulties. Hindu traders are the principal sources of loans and they charge extremely high rates of interest. Charges vary from 5-7 Rs. per 100 per month with surety (family gold etc.) or up to 10/100 Rs. without. Both landlords and tenants use this form of credit; landlords rarely supply credit interest free to their tenants, although they may act as guarantors for loans taken from Hindus. Occasionally, money can be raised by mortgaging land but Hindus have traditionally been barred from acquiring land by this method.

Loans are repaid after harvest and sometimes, whole crops are effectively mortgaged to traders, which leaves

little for the farmer. Money for inputs, water and tractor hire is normally obtained from livestock or melon and vegetable sales.

There seems to be virtually no use of institutional credit for production purposes. Producers, in the Bolan weir command area, obtain credit for seed and fertiliser purchase from commission agents in Quetta; transport to market is paid for directly by the commission agent at Sibi or Quetta. The producers receive a statement at the end of the season and the balance owing after all loans have been deducted. No interest is charged, but the commission agent takes his 10% fee and has some security of supply. Commission agents never send inspectors to look at the crops they are financing.

1.14.2 Markets

The most important market is for fodder, vegetables and melons at Quetta; the Sibi market is the second most used. Access to markets is severely restricted by a lack of all-weather roads and thus markets are very localised in the Lahri and western piedmont regions. Prices tend to be considerably lower in these closed markets.

Bigger farmers market melons direct to Karachi and on to to Dubai in some instances.

1.15. FARMERS' PRIORITIES

Farmers stated priorities are simple enough but are difficult to solve cost effectively. They include the following:

a. Provision of improved flood spreading works or electricity for pumping

b. Provision of bulldozers for bundat and Gandha construction

c. Increased mechanisation for timely cultivation and sowing in sailaba

d. Improved access to chemicals and spraying equipment for pest control, particularly for melon and vegetable production.

e. Drinking water supply was the most commonly expressed need in almost every unsupplied village.

No agricultural technology priorities were articulated.

2. RECOMMENDATION DOMAINS

The following categories are suggested for grouping farmer circumstances which require similar interventions or approaches to extension.

2.1 FARMERS WHO USE IRRIGATION

2.1.1 Perennial water delivered by canal

2.1.1.1 Landlord-tenant group

a. Cash croppers

This group may have limited access to capital and inputs may be specified and provided by the landlord. These people are mainly melon and vegetable growers. The landlord-tenant structure can be used effectively to disseminate information and demonstrate interventions; a large group of farmers can be reached by convincing landlords of improvements in practices.

b. Subsistence croppers

This group has no credit facility for inputs, although some landlords may supply fertiliser. Interventions should be focussed on minimal production costs; the alternative is to demonstrate the economic worth to landlords in such a way that they offer more comprehensive credits or deferral of payment for mechanisation and fertilisers. This group comprises mainly of wheat and fodder growers, and may at times overlap with 2.1.1.1 a.

2.1.1.2 Owner occupiers

a. Cash croppers

Credit is provided by commission agents; if proposed interventions in vegetable or fodder growing for this group require higher input costs, it will be necessary to convince commission agents to provide sufficient credit. This group should be the most responsive and a good target community for on farm trials. These farmers are experienced and knowledgable; if an intervention has genuine merit, then it it is likely to be rapidly adopted by them.

b. Subsistence croppers

Little or no credit is available and fertiliser use and adoption of improved varieties are not common. These farmers are primarily wheat farmers who could make big improvements in productivity. Provision of improved

credit is called for before more intensive practices can be adopted.

2.1.2 Farmers who use pumped irrigation

2.1.2.1 Cash croppers

Whether for landlord, owner occupier or tenant, the packages developed must be rigorously evaluated for good economic performance and constantly reappraised as market prices and fuel costs change. A large proportion of farmers in this group have poor access to markets and this must be taken into account, as local markets are small and operate at lower prices than elsewhere.

2.1.2.2 Subsistence croppers

A very low input low output traditional agriculture is practiced. Credit, cash and supplies of inputs are very scarce. The most likely target farmers in this group would be the Sardar and or family members who are concerned with farming. They will be less risk averse than smaller farmers: if improved varieties or practices requiring minimal inputs are developed, the extension process has to start at the "top".

2.2 FLOODWATER CULTIVATORS

2.2.1 Farmers with access to mechanisation

Farmers in this category may be either tenants or landlords who have sufficient financial resources to own or hire tractors for bundat making and timely cultivation.

2.2.1.1 Areas with reliable flooding and soil water retention

This is the least risky portion of farmers who operate a difficult but well adapted farming system. Productivity improvements would relate to more efficient and timely use of machines and interventions in soil management practices.

2.2.1.2 Areas with poor reliability of flooding

It is difficult to address any research or extension directly to this group, as they operate the least secure of insecure systems. However, any technology or improved husbandry that is developed for cultivators with reliable water, can also be used by this group. The major intervention needed is an improvement in flood water supply or provision of perennial (pumped) water for irrigation. Failure to solve this problem will

result in this group of cultivators leaving the land to seek work elsewhere; although many in this group may already work as labourers in Nasirabad or elsewhere, they have not yet given up sailaba farming.

2.2.2 Farmers who rely entirely on animal power

This is by far the largest individual group of cultivators who are only able to cultivate reliably watered lands, and often have more land than they can manage in a timely way. Improvements will occur if there is improved or cheaper mechanisation. Extension and demonstration should concentrate on key farmers who are willing and able to innovate; this does not necessarily imply the sardar.

2.3 FARMERS OF BOTH IRRIGATED AND SAILABA LAND

Any improvements in productivity under irrigation are likely to diminish the need for sailaba production. Farmers with access to machinery will continue to cultivate sailaba crops as long as timely work can be done without competition for labour required in irrigated cropping. Efforts should concentrate on improving the performance of irrigation and adding only those developments in sailaba cultivation that fit; cash flow should improve due to better income from irrigated production, but the farmer himself will decide the worth of investing some of that in say, tractor hire for improved sailaba production.

3. SUGGESTIONS FOR EXPERIMENTAL AND DEMONSTRATION PRIORITIES IN KACHHI DISTRICT

3.1. INTRODUCTION

3.1.1 General points

The following suggestions for research, demonstration and extension priorities are made on the basis of the types of farming system in Kachhi and the constraints that farmers face in operating or modifying their systems. A more detailed explanation of the different types of trial (verification, developmental and innovative) is given in the volume titled "Methodology".

3.1.2 Adaptive research in Kachhi

We have seen that sailaba farming is dominant in Kachhi, and this immediately raises questions about the level of investment that can be made in improving productivity; risk and uncertainty are high and the amount of existing relevant experimental work into sailaba cultivation is very limited. Opportunities in soil and water management exist, some of which are ideas that need testing and demonstration rather than true experimentation.

As irrigated cropping is concentrated in small discreet areas, it is difficult to suggest innovations which are universal. We must accept that the topics we choose for investigation may have a localised effect although this should not mean that they are unimportant.

3.2. IRRIGATED CROPPING

3.2.1 Trial work

3.2.1.1 FERTILISER TRIALS

Fertiliser use on all crops in Kachhi is very variable and substantial differences in applications can be seen between villages separated by only a few kilometers. Although credit is a major constraint to fertiliser use on cereals, money is available to buy inputs for melons and tomatoes. Fertility management is neglected in a surprisingly large number of villages, particularly along the Sanni-Gandawa piedmont and dung is often thrown away instead of being used on the land.

3.2.1.1 a. Wheat

In area terms, wheat is the principal crop and many improved varieties are in use which are underfertilised. Satisfaction of subsistence food requirements remains a major priority in areas where markets are accessible and would therefore allow diversification into other cash crops. Since excess grain can be sold or, alternatively land can be released if production is improved, confirmation of appropriate fertiliser levels would have widespread application.

AR trials should look at applications on as few varieties as possible, on order to keep the experimental workload within reasonable limits. Since the local varieties are still popular, low doses in the range of 60:30 Kg. of nitrogen and phosphate per hectare should be evaluated.

Fertiliser rates on Pak 81 could be evaluated for Bolan Weir and Nari Headworks command areas where water is not a limiting factor.

Wheat cultivation along the western piedmont is constrained by the availability of water, and varieties such as Sonnalika or perhaps 711 would be more appropriate. Suggested levels of N&P for improved varieties are 40:20, 80:45, and 120:60.

3.2.1.1 b. Barley and Oats

Both these crops are important fodders, which are sold on the Quetta market: investigation of the optimum doses and timing of fertiliser application is therefore worthwhile. All the varieties used at the moment are local and have never been tested in trials. Low doses in the order of 40:20 and 60:40 N&P/Ha would be a good place to start. In the longer term, testing higher rates with improved varieties is desirable. Given the tribal structure in the fodder growing areas, finance and dissemination of recomendations should not be an obstacle.

3.2.1.1 c. Melons and watermelons

Cucurbits are the most common cash crop and are even exported to UAE. They are grown under generous irrigation in Dhadar and this means that the effect of large quantities of N could be usefully determined. Many crops are grown on the same land from year to year, and some farmers are already applying small amounts of Potash to improve coloration and quality. Acid forming fertilisers, such as ammonium sulphate are likely to have some impact on yield by lowering the pH, and this could be investigated. Suggested trial rates of NPK (nutrient Kg/ha) are:

N	P_2O_5	K_2O
80	60	0
80	60	60
160	110	0
160	110	110

Table 8

Melons are also grown under restricted irrigation in the Nithri area and the practice of pumping temporary winter season water from rivers seems likely to spread. A complementary fertiliser programme for this system should be evaluated using N&P and NPK fertilisers; rates up to 100:50:100 could be tested.

3.2.1.1 d. Tomatoes

By Baluchistan standards, a large amount of nitrogen and phosphorous are applied to tomatoes and there is little problem with obtaining credit for their purchase. As the early market is the target for most growers, a suitable regime for quality and optimum yield with early bearing is desirable. The value of potash for the later maturing crop warrants investigation as quality produce command a better price. Applications of nitrogen phosphate and potash should be split as follows:

Nutrient kg/Ha	@ transplanting	+30days	+60days	@pick2
N	45	45	22	22
P_2O_5	45	45	11	11
K_2O	45	45	11	11

Table 9

3.2.1.1 e. Sorghum fodder

The market for green fodders is very strong in Quetta resulting in substantial use (160:115) of N&P on local varieties in the Dhadar area. The timing and quantity of split applications at sowing, at 20 and 40 days post emergence could be tested for maximum yield. As the local varieties are day neutral and average temperatures are high, earlier plantings are possible: fertiliser regimes for this crop and a follow on ratoon forage crop could be investigated.

3.2.1.2 EVALUATION OF NEW VARIETIES

3.2.1.2 a. Wheat

Improvements in wheat production must account for the shortage of water and the resulting tendency to irrigate wheat no more than three, sometimes four times. Varieties with reasonable fertiliser response characteristics under sub-optimal irrigation are required. Short season varieties which flower early may allow irrigation water to be released for vegetable production in March-April.

Other important characteristics are the quantity and quality of straw, as it is the principal fodder in the irrigated areas. The current range of improved varieties are short strawed and do not match up to the local cultivar. Longer strawed varieties, such as Pirsabak 85 and Barani 83, or others with good lodging characteristics are preferred fot testing.

3.2.1.2 b. Sorghum

Higher yielding and more fertiliser responsive cultivars could be introduced, but must be carefully evaluated against the local "Toori" strain, which is a good performer in both irrigated and sailaba conditions.

Imported F1 hybrid sorghums, introduced in the Punjab by ADBP, have yielded 25-40 tonnes fresh weight at each of five cuts, taken at 35 day intervals. The fodder varieties tested were "Speedfeed" and "Jumbo" and were both imported from Australia. Seed is available in Karachi, and verification trials could be instigated to test these varieties in Baluchistan.

3.2.1.2 c. Cash crops

At the moment there seems to be little to be gained by introducing new varieties of melons and tomato. Two improved characteristics for tomatoes are desirable but it is questionable whether the scale of production justifies investigation. Earlier fruiting to catch the early market is desirable for January transplants, whereas high temperature tolerance is needed for the late planted crop which is picked in June.

3.2.1.3 IRRIGATION EXPERIMENTS

3.2.1.3 a. Irrigation scheduling in cereals

There are two facets which warrant experimentation: reducing the number of irrigations given to fodders, and optimising the timing of restricted irrigations in wheat. Yield measurements should be correlated to the number and timing of

irrigations for barley oats and sorghum over the tillering, booting and heading periods.

The practice of cutting off irrigation at different times to stagger harvesting could also be investigated.

3.2.1.3 b. Post germination irrigation

In most years wheat and barley establishment is often poor, and good compensatory tillering only occurs following good spring rains. The interval to the first irrigation after emergence is usually 25 days but may be as much as 40days.

The effect and worth of a light watering (50mm) 3-4 days after emergence should be determined, especially as there is little competition for water at this time.

3.2.1.3 c. Supplemental irrigation of melons

With more and more melons being raised on one or two early irrigations in February-March, investigations should be carried out into the optimum amount of water applied and the number of early season applications. Melons are very efficient users of soil moisture and develop deep roots. Good establishment with a number of shallow irrigations should be followed or preceded by larger quantities of water to create a soil moisture reserve to a depth of 2m.

In some areas of Kachhi, melons receive too many waterings, even on light soils; the optimum number and interval between irrigations for loamy and sandy soils should be determined.

3.2.1.4 CULTIVATION TRIALS

3.2.1.4 a. Beds and furrows for tomatoes and melons

Tomatoes are normally grown on ridges which can be both large or small and both Roma types and taller varieties are staked for support. Growing tomatoes on beds with irrigation furrows set about 2m apart would allow the bush type crops to be grown on the inside of the ridge, "on dry land". Access for picking and weed control should be much more easy than at present and irrigation should be less time consuming.

Melons are often grown on very narrow beds or broad ridges, and the seeds are placed towards the top of the irrigation channel. The foliage often grows down into the channel and is wetted and so rots or it becomes more susceptible to attack by mildews. On wider (2m) beds, the seed can be placed on the dry side of a furrow and the foliage can be trained over dry ground: there is less likelihood of fruits rotting in contrast to current practice.

3.2.1.4 b. Soil Salinity

One further aspect to be considered is the salinity evident in some soils. Seeds should not be placed close to the top of the ridge or at the capilliary fringe where salt accumulates. In notably salty areas, irrigating by alternate furrows could be tested against watering each furrow, or planting on one side of a narrower bed with closer spaced furrows could be tested against a wider bed system, eg:

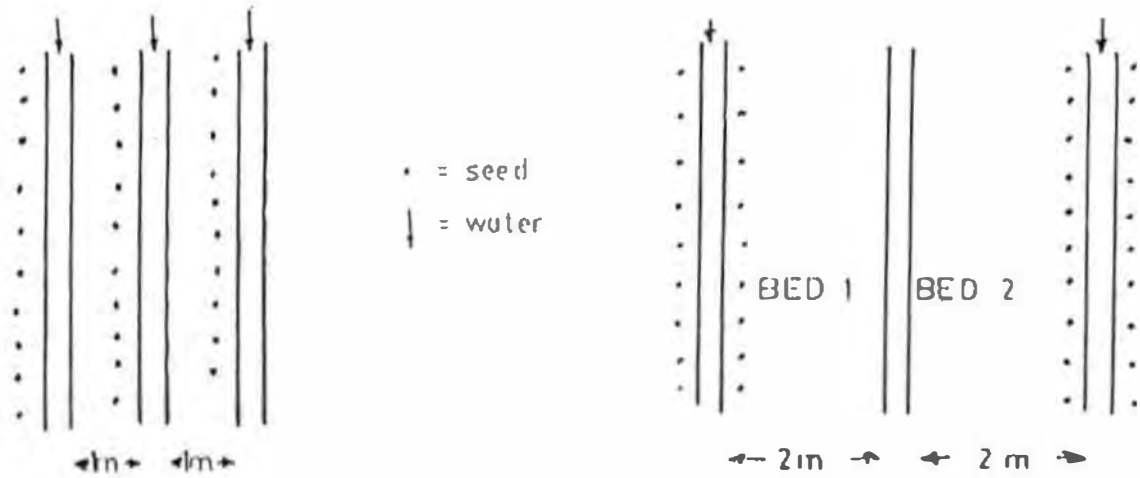


Fig 1

3.2.1.4 c. Deep tillage in cereals

Work in the barani areas of Punjab has shown useful responses to deep ploughing with disc ploughs (BARD project). Preliminary results indicate that the the yield response depends on annual deep ploughing and there is little carry over effect. Mouldboard and disk ploughs are not widely used in Kachhi, and some investigation should be made on irrigated soils working at 30 and 45 cm depth.

The department also has deeper working subsoiling tines (without "wings"), but no tractors powerful enough to pull three units at one time. However, the effect and economic worth of subsoiling at 60 and 80 cm below ground level can be calculated from experimental data produced by subsoiling with one tine only, using existing 65HP tractors.

3.2.1.5 CONTROL OF PESTS AND DISEASES

3.2.1.5 a. Insects

Some farmers apply pesticides on melons against red pumpkin beetle, cutworm, various beetles, fruit flies, aphids (vectors of cucumber mosaic virus) and fruit borer. Pesticides are rarely applied at the right time or in the

right quantities. The same is true for the control of fruit borer and aphid in tomatoes. A good package of insect control using persistent systemic and knock-down pesticides should be evaluated. Chemicals with acceptable LD50's should be tested, such as Diazinon, Ekalux, Malathion, Dimecron and Cymbush. In the longer term, ultra low volume (ULV) techniques should be investigated as water is often not available near to a field when spraying is required. The relative merits of spray and granular application should be assessed as the latter are much easier for farmers to apply, but are dependent on irrigation for immediate effect.

The effect of Padan and Furadan on establishment and yield of fodder sorghum should be investigated. Work in the Punjab has shown very much improved stands due to good control of sorghum shoot fly and stem borer.

3.2.1.5 b. Diseases and deficiencies

Vegetables

Powdery mildew is common on cucurbits and is treated with (out of date) Benlate by some farmers. It is not easy to assess the effectiveness of control, but mildews have become increasingly resistant to Benlate elsewhere in the world. Trials to determine the effect of Benlate and alternatives are needed and it would be worth determining the optimum timing of the first and subsequent sprays.

From farmers' descriptions, virus mosaic is also a problem, and this can only be controlled by killing aphids at an early stage.

Tomatoes suffer mainly from virus diseases, and so the same protection measures apply. Seedling blight and poor establishment are also a problem with both imported and local seed and alternative seed treatments should be tested.

Wheat

Rust affects most of the varieties grown in Kachhi, especially as the resistant varieties (Pak 81, Pawan, and Sonnalika) require more irrigation than the others and are therefore not planted so widely. Resistant varieties which match the requirements for fertiliser responsiveness with few irrigations should be sought out and tested. The Provincial Wheat Botanist should be consulted about promising varieties.

3.2.1.6 WEED CONTROL

Weeds in cereal crops are an important source of fodder and are usually collected by hand. By contrast weeding in vegetables is often physically difficult and very labour intensive and is therefore not done as frequently or as well as it should be. If cultivation on beds is introduced, the task should become easier, especially if improved hand weeding tools are introduced (hoes, for instance). A weeding trial should compare the yield improvement in fodder, straw and grain against the fodder yield of weeds, and determine which is the more cost effective practice.

Chemical weed control for melons and tomatoes are probably economically justified and affordable. Once the principal weeds have been correctly identified, suitable chemical measures can be tested in verification trials.

3.2.1.7 AGRONOMIC PRACTICE

3.2.1.7 a. Rotations

Rotations are so infrequent in the farming systems of Kachhi that a verification trial cum demonstration is needed. Melons are the obvious crop to choose because continuous cropping has been practiced for more than nine years in some fields. There is increasing evidence of soil-borne disease amongst the problems now occurring on cucurbits. Data on yields and incidence of pests and diseases needs to be collected over a number of years. A 3-4 year rotation involving melons-wheat-vegetable-wheat (or fallow) seems reasonable.

3.2.1.7 b. Fodder plant density

The optimum plant densities with and without fertiliser should be established for oats, barley and sorghum, as there is great variation in seed rates and reported yields for both these crops. Suitable treatments are summarised below:

	Seed Rates			
Crop	1	2	3	
	kg/Ha			
Barley	100	130	160	All +/-
Oat	70	100	130	Fert.NP
Sorghum	25	35	50	

Table 10

3.2.1.7 c. Propagation of seedlings

Tomato seedlings in Kachhi are often of poor quality when they are transplanted out; although tomatoes are very tolerant of water stress, there is a strong correlation between degree of stress and yield penalty. An experiment can be undertaken to test the yield improvement from pot raised seedlings, planted into recently irrigated soil compared to current practice. In addition, we can evaluate the effect of shade (netting or "local" material) on the quality and subsequent performance seedlings.

3.2.1.7 d. Trellis Systems for Tomatoes

For the tall varieties a simple post and 2-wire trellis system could be tested and costed against the existing system which has both high capital and labour requirements: as tomatoes are grown on the same land year after year, a semi-permenant trellis, running along the length of a bed, should be cost effective and reduce the peak labour requirement for staking up and tying on.

3.2.1.8 EVALUATION OF ALTERNATIVE CROPS

The opportunities for introducing new crops in Kachhi are limited by the universal lack of water and the continuing importance of subsistence wheat production. Many parts of Kachhi are not well served by roads, telephones and electricity and consequently marketing of higher value crops is so difficult at the moment that farmers cannot change to cash crops.

Introduction of fruit crops in the perennially irrigated areas is the only real possibility and is being explored by the Department. The salinity of shallow well water is too high for satisfactory fruit production in many places and so the main target areas would be downstream from Nari and Bolan weirs.

Mangos appear to be preferred by farmers, although rough lemons, lemons and limes are found in the small garden orchards of the sardars. Varieties should be screened for best performance, using more salt tolerant rootstocks where possible. If economists feel that future markets will support more sapodilla than that produced in Las Bela, introductions could also be made. Sapodilla fruits more quickly than mango, guava, and citrus and is therefore more commercially attractive.

3.2.1.9 GRAIN STORAGE

Comparison of grain losses in traditional storage vessels should be undertaken. The practice of chopping and mixing Sri or Neem leaves with grains is confined to a few villages. If the practice is as effective as claimed, this technology should be encouraged throughout the district.

3.2.2 Demonstrations

3.2.2.1 CULTIVATIONS

Mechanisation is increasing throughout Kachhi, but many farmers may not be making the best use of their investments. Ploughing is often done dry, even when water is available to bring the land into condition. Seedbeds are often cloddy and many operators seem unaware of how to adjust and set up mouldboard and disc ploughs. Demonstrations of correct implement preparation and operation should be made in all parts of the district. 65HP tractors are not sufficiently powerful to pull a four furrow mouldboard plough, and demonstrations should show three furrow models in operation. Initially these demonstrations could be targeted at the tractor owners and their drivers, particularly those who hire out their machines.

3.2.2.2 PUMPSETS

Electrical and diesel powered centrifugal pump sets, working in the main river channels, are found more and more in the plain. The engineering staff in the Adaptive Research programme should review and test the combinations available and demonstrate the most efficient and cost effective units. Maintenance demonstrations are also necessary, judging by the down-time on units operating along the Bolan river.

3.2.2.3 POST HARVEST OPERATIONS

Mechanical threshers are available, but appear to be under-utilised or no longer operational. Grain threshing is a tedious and time-consuming business for many cultivators, and instruction in the operation and maintenance of these machines may improve the situation.

3.2.3 Extension

Extension priorities should include provision of information in pamphlet and poster form on the following topics:

a. Pesticide safety, pest recognition (particularly in melons and tomatoes), mixing and applying chemicals and sound recommendations for the control of named pests.

b. Instructions on operation and maintenance of tractors, threshers, cultivation implements and spraying equipment.

c. Irrigation and fertiliser recommendations for wheat.

3.3. RAINFED AND FLOOD-IRRIGATED CROPPING

3.3.1 Trial work

3.3.1.1 FERTILISER TRIALS

3.3.1.1 a. Residual phosphate

Continual cropping of sorghum and pulses should have depleted the soil of available phosphate. Experiments with wheat in upland Baluchistan indicate strong responses to phosphate, and this could be investigated over a number of years for the sorghum-pulse staple crop. Trial levels of 0 and 60 kg of phosphate per hectare are suggested.

3.3.1.1 b. Nitrogen placed into moisture

BARD reports economic responses to nitrogen placed into moist soil under rainfed conditions in the "Rod Koi" areas of the Punjab. Although this work has been done for wheat, and under a better rainfall regime than experienced in Baluchistan, sailaba floodings place substantial quantities of moisture in the soil. The effect of limited quantities (30-50 kg N/Ha) applied to the sorghum-pulse crop could be investigated over 3-4 years to determine the benefit, reliability and economic worth of this practice.

Mung introductions in the BARD operational research programme are given similar quantities of nitrogen; as mung is the only cash earning crop in sailaba, the economic justification for fertiliser use may rest on the incremental yield of mung beans which can be sold.

3.3.1.2 EVALUATION OF NEW VARIETIES

3.3.1.2 a. Millet

Millets have been traditionally grown on the sandier soils, but are not favoured because of their poor forage quality. New introductions with good biomass production should be evaluated under sailaba conditions, particularly on the lighter or less well watered soils. Three varieties have been selected by BARD for further evaluation and these could be a useful start in Kachhi. The varieties are called DBR3, Composite 75 and Composite 2 but BARD should be consulted for further details.

3.3.1.2 b. Pulses

Alternative lines of moth bean are unlikely to be available, but there are many options for mung cultivars. Advice on appropriate varieties for sailaba conditions is needed and, to that end, the pulse co-ordinator at PARC has been asked to assist.

3.3.1.2 c. Mustard/rape

A number of improved varieties of oilseed have been tested by ARI, but only under irrigated conditions. Varieties screened by BARD displayed the same relative performance under rainfed and irrigated conditions although the yield levels were considerably higher when watered. Good forage characteristics are required by farmers, and selection of two or three promising cultivars for initial screening should be followed by agronomic work on plant density and time to planting after flooding.

3.3.1.2 d. Selection and collection of local sorghums

There are still at least four identifiable local varieties of sorghum in use in Kachhi. The best appears to be "Toori" which has a closed drooping panicle, and good fodder value. Similar varieties are reported elsewhere, but it is hard to tell if they are the same variety grown in a mixture with others, or whether they are an outbreeding type. The local varieties seem to be very well adapted and should be collected, classified and compared with "exotic" material. They may offer good material to breeders in other programmes and it is conceivable that they could be improved for sailaba conditions.

3.3.1.3 WATER MANAGEMENT EXPERIMENTS

3.3.1.3 a. Second waterings to sorghum-pulse mixed crop

The later rains and floods in August and September are used to grow wheat or oilseeds, which can be cut as fodders if there is insufficient moisture for a seed crop. The value of applying this late floodwater as a supplement on the sorghum-pulse mixed crop should be investigated. Some control over the flood water is necessary (see 3.3.1.4 b) otherwise the pulse crop can be damaged, and this is why farmers do not do so at the moment. The grain production of mung and moth could improve considerably from a second watering which improves the moisture availability at flowering which is the critical growth stage.

3.3.1.3 b. Depth of water retained in bundats

Work in NWFP has indicated that soil moisture which lies beneath the root zone can rise through the profile along an inverted temperature gradient in November-December. The gradient is caused when the soil surface temperature falls below that of the subsoil in response to declining atmospheric temperature. If this is true, rising moisture becomes available to sorghum and pulses at grain fill, and therefore makes a significant contribution to yield. This phenomenon may, in part, explain why farmers traditionally infiltrate more water than is necessary to fill the root zone. A set of simple experiments in sailaba plots (or under simulated sailaba conditions) should be conducted to determine the effect of the depth of water stored and infiltrated in a bundat. Suggested treatments are 30, 45 and 60cm.

In connection with these experiments and the management of sailaba water in the field, it is important to find a method of controlling the inflow and outflow of water to and from a bundat. A spillway which allows water to pass from one field to another is needed to retain a predetermined depth of water in the field. The spillway must be designed to minimise erosion and pass the peak flow delivered by the supply channel. Controlled flood spreading to irrigate the largest possible area offers perhaps the best single way of improving the productivity of this type of farming.

An outline methodology for determining the size and design details of spillways is given in the volume "Supporting Information", but needs further development.

3.3.1.4 CULTIVATION TRIALS

3.3.1.4 a. Land preparation before flooding

Primary cultivation before the summer or spring floods should, in theory, improve infiltration and reduce the time between flooding and sowing. It should also result in reducing the cultivation time after flooding and it should be possible to produce a better seed bed using mechanised (or improved animal powered) secondary tillage if heavy cultivation does not need to be done at the same time. Precultivation with disc plough working deep and shallow should be compared with the desi plough: all of these must be compared to cultivation after flooding. Measurements that should be recorded include:

a. Days to sowing after flooding, days to harvest after germination.

b. Grain and vegetative yields.

c. Estimated percentage germination, and stand density.

In the longer term, deep strip tillage using tractor-drawn chisel ploughs offers the apparent benefits of deep tillage with a reduced power and cultivation time per hectare.

Improvements in clod crushing are indicated for good tilth and hence good germination. In mechanised farming, cambridge and heavy rolls can be tested. Fewer options exist for animal users unless improvements can be made to the existing sohaga. or engineers develop a simple animal drawn roller.

3.3.1.4 b. Stability of bunds and distribution of flood water

If bunds fail, as they often do, the time that water remains ponded in a field is reduced to the point that little is stored in the soil profile. In this case the crop is likely to fail to head, but it can usually be cut for fodder. Bunds fail due to poor compaction and localised weak spots caused by rat holes or irregular land levels immediately behind the embankment. They may also fail because the flood water is too difficult to control and overtops the bund itself. The need to control water has been explained above, but techniques of improving bund integrity are also needed. Such improvements are difficult to cost and justify.
Innovations to be tried include stone pitched inlets and outlets to and from bunds,. compaction of the embankments during construction, improved rodent control and rough

land levelling of the field surface behind an embankment.

3.3.1.5 CONTROL OF PESTS AND DISEASES

3.3.1.5 a. Seed treatment

Sorghum suffers from loose headed smut, and farmers never eat infected heads and rarely feed them to animals. Losses seem to be of the order of 10-15%, and could easily be controlled using an appropriate seed treatment. Rough calculations indicate cost benefit ratios of more than 20:1 and it is therefore worth testing 2-3 products to determine the most cost effective treatment. Vitavax, Ceresan and Agrosan are supplied by the Department, and should be tested before any other alternatives are sought.

3.3.1.5 b. Aphid control

Pest control in saltaba crops is risky due to the low value of the product and the many factors (mostly beyond the farmer's control) contributing to low yields. However, farmers report total failure of the mung and moth mixed crop from virus mosaic/yellows. They report that aphids infested the crop before the disease symptoms appeared and that they would like to have controlled them. Remembering that minimum cost is the most important factor, cheap insecticides should be evaluated for future use in mixed crops. Techniques such as spot and half strength spraying should be tried to establish cheap but effective control of aphids and (as a bonus) pod-borers.

3.3.1.5 c. Control of rodents

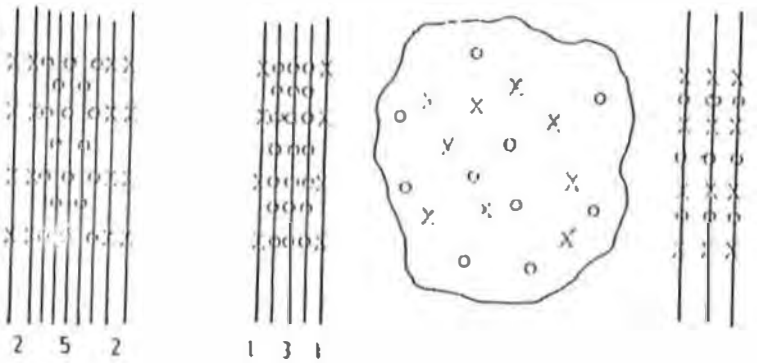
Zinc phosphide is used by farmers to control rats, but with limited success. Simple techniques of trapping might be far more effective, and could be easily tested on farmers' fields. Advice on good, cheap, mass produced snares or traps is needed.

3.3.1.6 AGRONOMIC PRACTICE

3.3.1.6 a. Line sowing versus broadcast seeding

Line sowing of sorghum and pulses is done when the ground surface is too dry for germination and the seed must be planted into moisture at 100-150mm. There is no information on the independent effect of seeding method on yield, and on the spatial orientation of the pulse and sorghum crops in a stand. Mixed crop experiments are not easy to do, but the arrangements shown below could be investigated.

Fig. 2



x = sorghum : o = pulse

3.3.1.6 b. Plant densities

In conjunction with spatial arrangement, plant density is an important factor of yield in mixed crops. The combinations of seed rate used in a sorghum-mung-moth-(sesamum) mixture can be very different in similar conditions. A range of seed combinations should be investigated to measure the proportions of grain, pulse, and fodder yield and to determine whether one particular mix offers distinct advantages and can be recommended in the future.

3.3.1.7 EVALUATION OF ALTERNATIVE CROPS

Castor bean is grown under sailaba conditions in Las Bela and is the main "cash" crop in this system. Although the market is nt Karachi, the performance of the Las Bela local and an improved type (DS30) could be planted to test farmers reactions and determine the best agronomic practices for it in Kachhi.

Chickpea is grown on residual moisture in Nasirabad, and this is in principle, little different from sailaba cultivation. Aschochyta and Fusarium resistant varieties should be tested under sailaba conditions both as a monocrop or as a mixed crop with sorghum. Yields of introduced varieties (particularly CM72) in BARD's project areas have been very encouraging.

3.3.2 Demonstrations

3.3.2.1 UREA TREATMENT OF STRAWS

Improvements in the fodder value of wheat straw treated with urea, have been confirmed by the Pak-German Self Help Project. Economic improvements in liveweight gain have been demonstrated in goats and big ruminants although there have only been marginal improvements with sheep.

This technique is commonly used for sorghum straws in other parts of the world, although some work remains to be done on the optimum concentration of the urea solution applied (3 or 5%??). The Self Help project is already working at Jalal Khan near Bhag, and can provide instructions on the preparation of treated fodders. Some liason in conducting demonstrations of both wheat and sorghum treatment is desirable.

3.3.2.2 SPILLWAYS IN BUNDATS

A number of stone pitched spillways should be constructed between bunds in visible sites to demonstrate improved control of floodwater. Before this can be done, designs and calculations must be prepared, and an outline method for doing this is given in "Supporting Information".

3.3.2.3 SEED TREATMENT

Demonstrations of seed treatment to control smut in sorghum are very easy to set up and could interest the farmers enough to adopt the practice.

3.3.3 Extension

Given the lack of research into Sailaba agriculture to date, it would be a little premature to make suggestions for extension. Once the Adaptive Research programme has some tested interventions to recommend, there will be something to do in extension. Meanwhile activities will have to focus more on the irrigated sector.

3.4. PRIORITIES

All verification trials have a high priority because:

a. the technology has already been tested elsewhere at a general level, and it is expected that it will have similarly useful results.

b. the experimental time required before recommendations can be formulated is expected to be shorter than for other trials.

c. the methodology is simple and therefore best suited to the early stages of an Adaptive Research programme.

Initial work should concentrate on verification trials on pesticides on vegetables, irrigation and fertiliser on wheat, and water management in saiiaba.

ANNEX A CLIMATE DATA

ANNEX A1 Rainfall Data

Rainfall data for stations lying in each sub-ecology of the district have been collected from the report "Hydrology of Baluchistan" by Wirasat Ullah Khan. The average monthly rainfalls for the period 1910--1960 and sometimes longer are presented in this report.

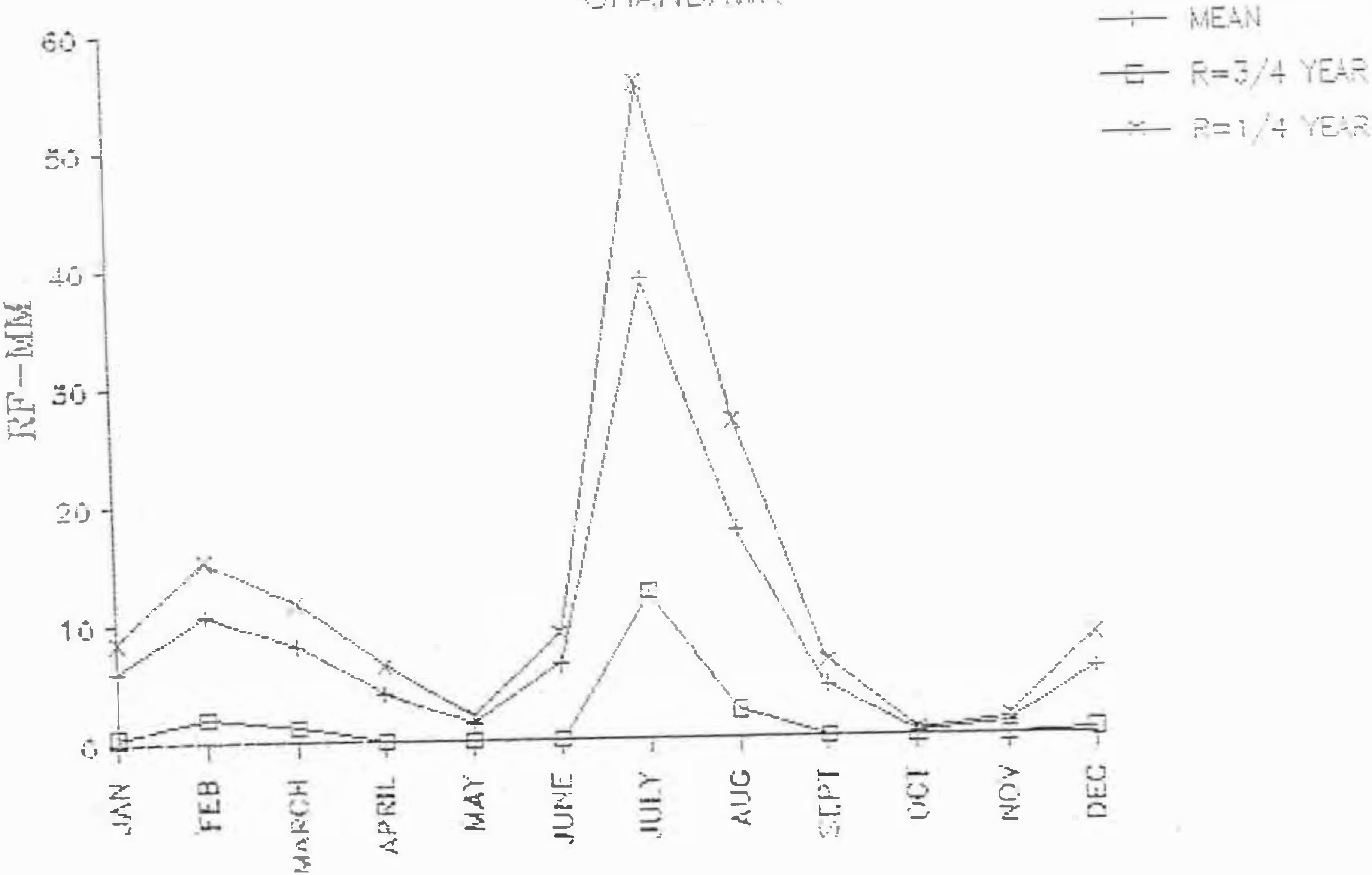
This data has been fed into a rainfall frequency analysis programme, based on the Gumbel probability distribution and the probability of exceedence has been calculated to give a measure of the rainfall reliability. Tables and graphs of the minimum expected rainfall once in four years and three times in four years as well as the mean value are presented for the following stations:

1. Mushkaf
2. Gandawa

The reliability of rainfall has been presented to illustrate the tiny contribution it directly makes to cropping; the immediate contribution from rainfall is rarely sufficient to encourage seeding, and hence in most areas sowing is done following floods or runoff due to rainfall falling over large catchments, some distance from the cropped lands.

RAINFALL SUMMARIES FOR BAEARP DISTRICTS

GHANDAWA



ANNEX A2 Temperature Data

Temperature data for the sub-ecologies of each district has been a little more difficult to obtain and Pakistan Meteorological Service "normals" for 1898-1940 and 1931-1960 have been used. For stations not covered by PMS sites, shorter term data from WAPDA Surface Water Hydrogeology Project stations has been used. This data is a little more erratic, and generally covers the period 1960-1975, although some stations were more shortlived.

All the available average monthly maximum, minimum and mean temperatures have been collated, calculated and converted to degrees celsius before being presented in the accompanying tables and graphs. The following stations are covered:

1. Gandawa
2. Sibi

The idea of presenting the data is to illustrate the temperature "windows" through the season in relation to the choice of crops, varieties and new introductions. Data for Sibi has been used in the absence of data for Dhadar.

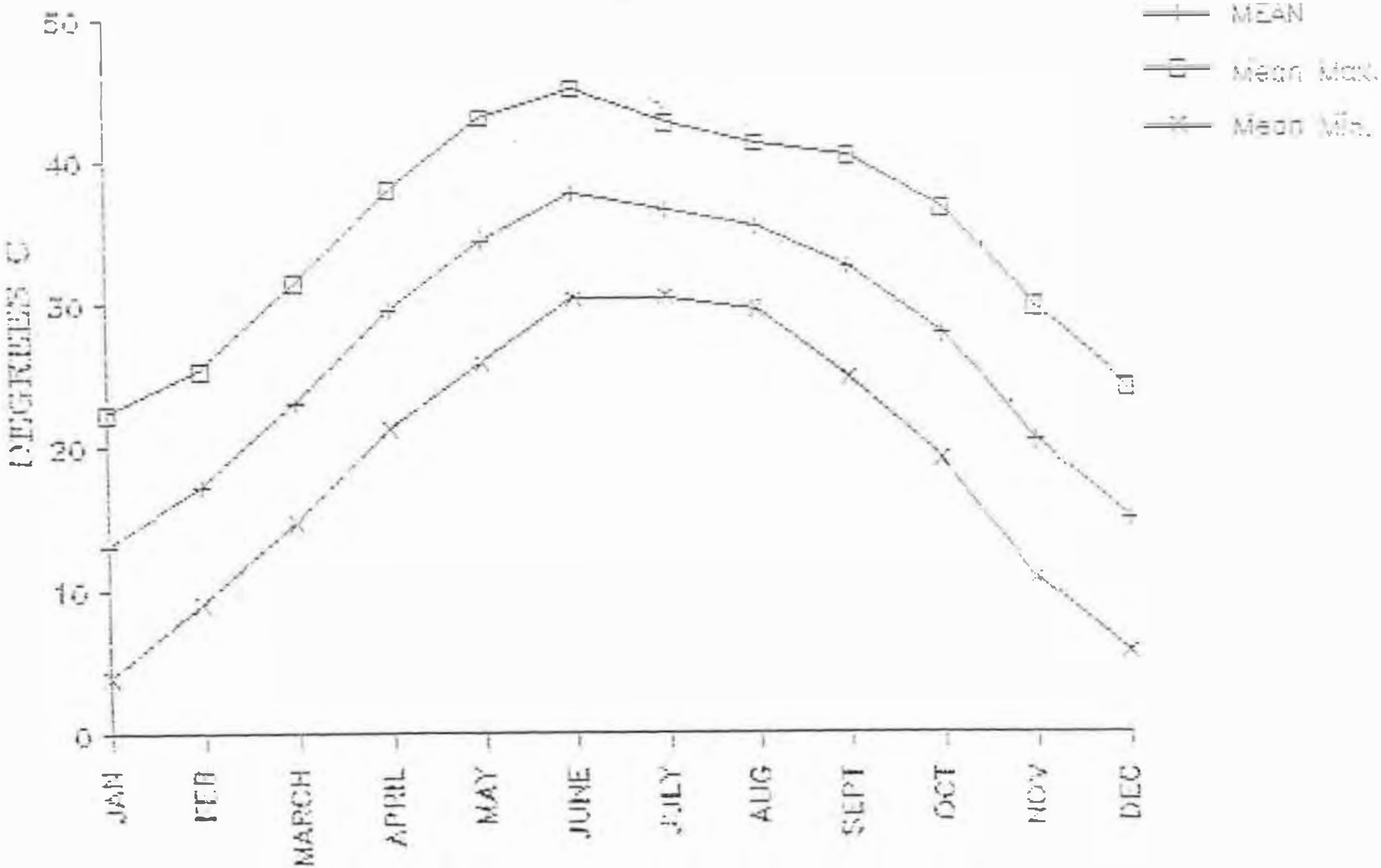
TEMPERATURE SUMMARIES FOR DHDARP DISTRICTS
MEAN, AND MEAN MAXIMA AND MINIMA Source met office normals 1898:1940 and 1931:1960

DEGREES C		MONTH											
DISTRICT	STATION	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
Kacchi													
MEAN	GANDAWA	13.1	17.2	23.1	29.6	34.4	37.7	36.5	35.4	32.5	27.6	20.3	14
Mean Max.*		22.3	25.3	31.4	37.9	43.0	45.0	42.6	41.2	40.3	36.6	29.8	24
Mean Min.		3.9	9.1	14.7	21.2	25.8	30.3	30.4	29.5	24.7	19.0	10.8	5
MEAN	SIBI	13.8	17.2	23.0	29.6	35.4	38.2	36.6	35.2	33.3	27.8	21.3	15
Mean Max.		21.5	24.7	30.6	37.5	43.3	45.5	42.3	40.8	40.1	36.6	30.5	24
Mean Min.		6.1	9.6	15.4	21.6	27.4	30.8	30.8	29.6	26.5	18.8	12.1	7

Sites marked * have data from 1965:1975, WAPDA SWHP

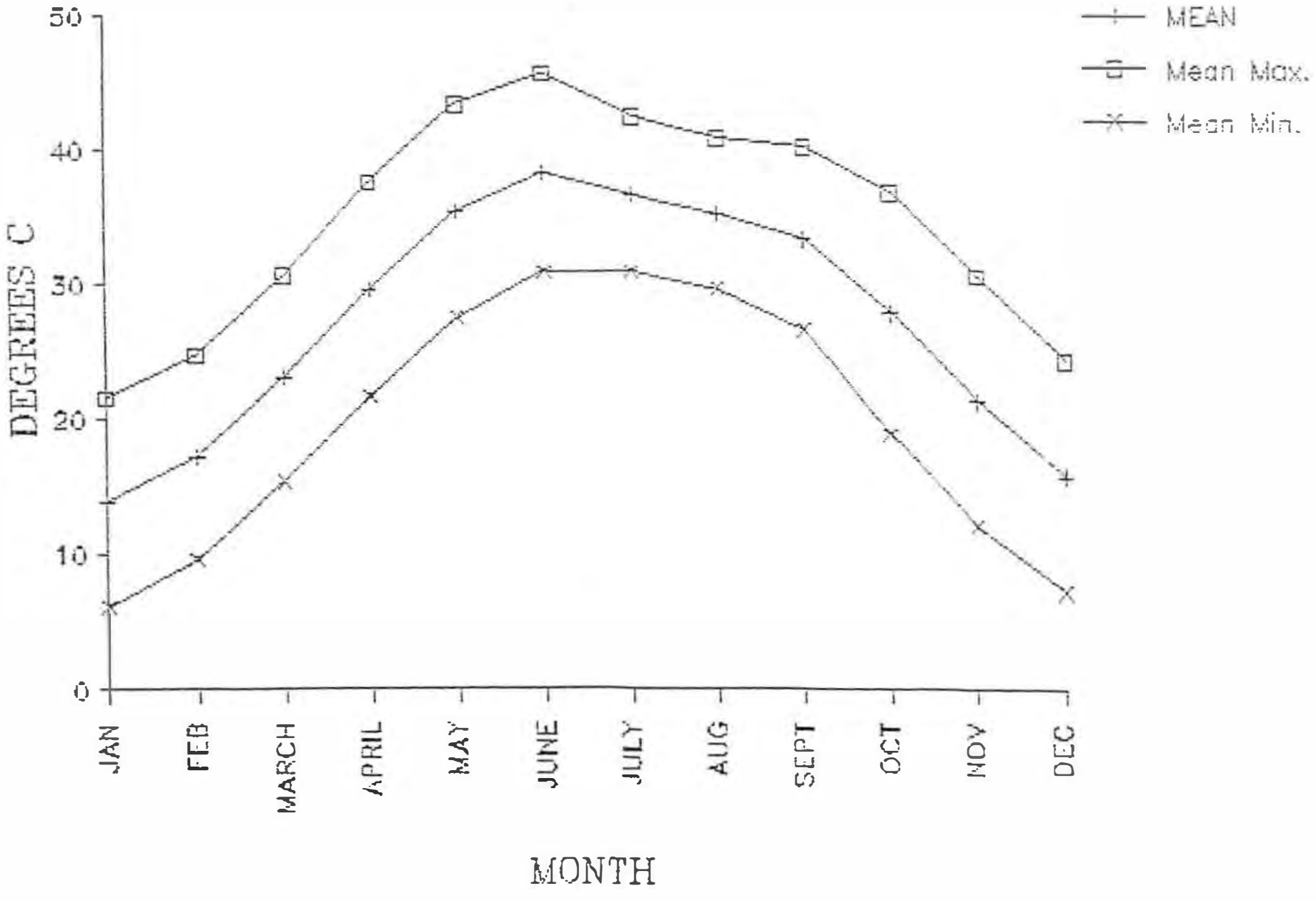
TEMPERATURE SUMMARIES FOR BAEARP DISTRICT

GANDAWA



TEMPERATURE SUMMARIES FOR BAEARP DISTRICT

SIBI



ANNEX B CROP CALENDARS

The crop calendars are presented for irrigated vegetables and field crops and dryland crops. The convention used is summarised as follows:

a. Both Gregorian and Hindu calendar months are given, as these are the two most commonly used.

b. Symbols are used to denote operations and growth stages in the crop season and each is contained within a box, delimited by sloping lines. The slope of the line at the beginning and end of a period indicates the time envelope within which operations occur; for instance, sowing of wheat may start early in October and finish in mid December, but farmers who only plant during the mid to late season (mid November onwards) have a shorter "window" in which they must complete the work.

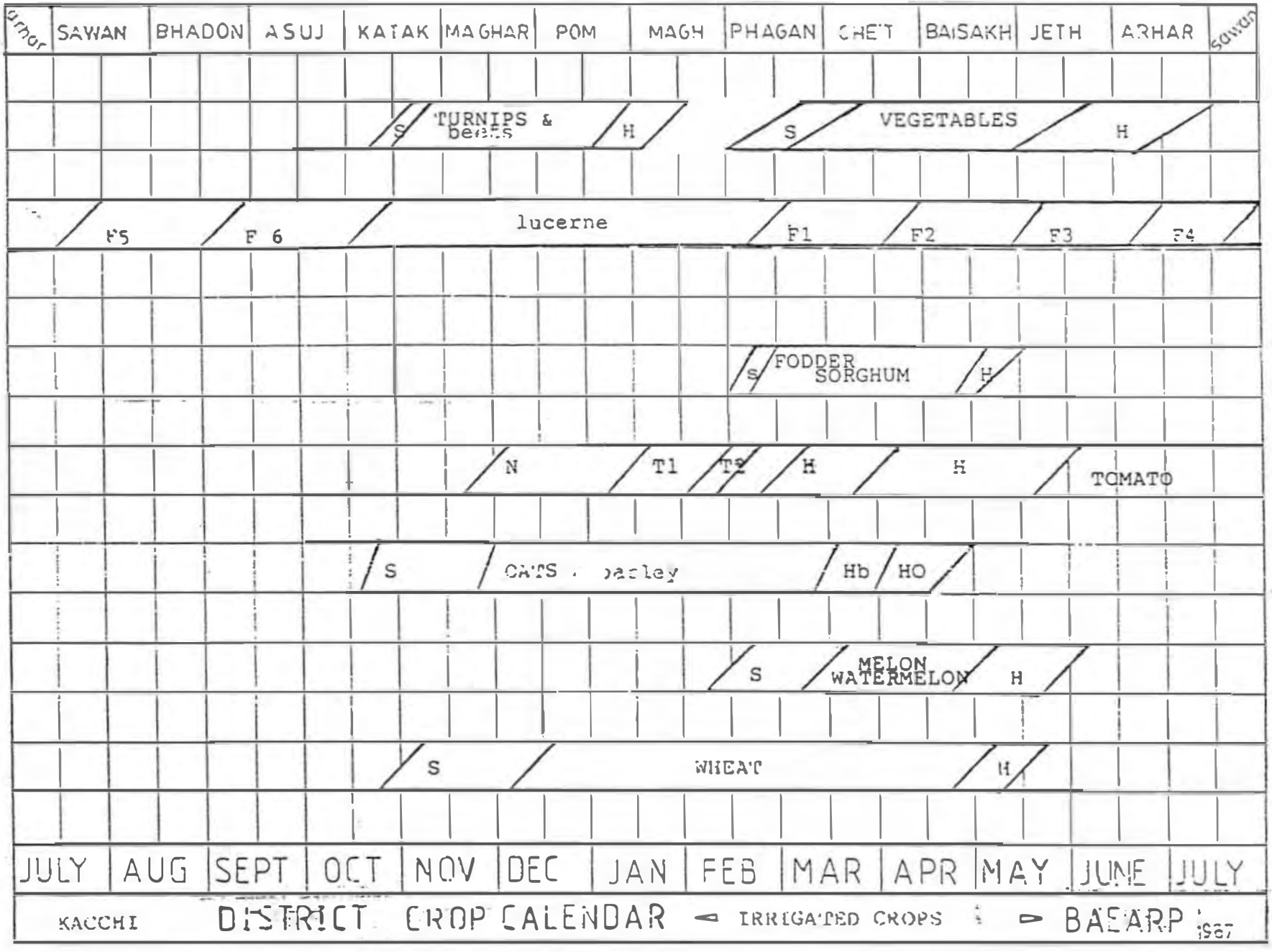
The symbols are annotated as follows:

S.....sowing
T.....transplanting
H.....harvesting
F.....cut of fodder
FYM.....application of manure
Fl.....flowering

c. Crops that overlap on the same line are relay cropped. Those which do not overlap are normally grown on the same land.

d. Crops separated by a horizontal dotted line are grown as a mixture. In some cases, crop mixtures are denoted by the labelling within the box.

e. Crops with adjacent boxes are alternative mixed or relay crops.


SAWAN
BHADON
ASUJ
KATAK
MAGHAR
POM
MAGH
PHAGAN
CHET
BAISAKH
JETH
ARHAR
SAWAN
S
TURNIPS & beets
H
S
VEGETABLES
H
F5
F 6
lucerne
F1
F2
F3
F4
S
FODDER SORGHUM
H
N
T1
T2
H
H
TOMATO
S
OATS . barley
Hb
HO
S
MELON WATERMELON
H
S
WHEAT
H
JULY
AUG
SEPT
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUNE
JULY
KACCHI
DISTRICT CROP CALENDAR
IRRIGATED CROPS
BAEARP 1987