

# Joint Border Survey of the Spring Breeding Areas of the Desert Locust in Baluchistan of the I.R. Iran and Pakistan

April - May 1995



FOOD AND AGRICULTURE ORGANIZATION  
OF THE UNITED NATIONS

Rome, 1995



**Joint Border Survey of the Spring Breeding Areas  
of the Desert Locust  
in Baluchistan of the I.R. Iran and Pakistan  
April - May 1995**

by

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**FOOD AND AGRICULTURE ORGANIZATION  
OF THE UNITED NATIONS  
Rome, June 1995**

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## Preface

According to its mandate, the Food and Agriculture Organization is responsible for the coordination of Desert Locust survey and control activities in Africa, the Near East and South-West Asia. Within this context, the Desert Locust Control Committee and the various FAO regional locust commissions have recommended the implementation of joint surveys in key locust breeding areas to assess the situation and promote the exchange of technical expertise between countries. Furthermore, ground surveys are clearly recognized as the most important component of any preventive Desert Locust control strategy.

Given the international nature and significance of the Desert Locust, the Director-General has recently initiated a new programme, the Emergency Prevention System (EMPRES) for Transboundary Animal and Plant Pests and Diseases (Desert Locust component), to better detect and respond to the first signs of increased Desert Locust activity in the Central Region which is a source of many outbreaks and upsurges.

The joint survey described in this report is a good example of implementing a survey to assess a large remote area in a short amount of time by using standardized methods and reporting forms to collect locust and environmental data. The findings of the survey can be used for planning purposes in the coming months not only in the two countries in which the survey was undertaken but also in neighboring countries that could potentially be threatened by the Desert Locust. Furthermore, the survey illustrates the type of cooperation that can be achieved between locust affected countries under the auspices of FAO.

FAO would like to express its sincere gratitude to the Governments of the host countries and to the members of the survey team. FAO encourages the undertaking of such joint surveys in the future on a regular annual basis and hopes that they can be extended to other key border areas in order to promote cooperation between countries as part of the early warning efforts against the Desert Locust.

Mohamed S. Zehni  
Director  
Plant Production and Protection Division



**Joint Border Survey of the Spring Breeding Areas of the Desert Locust  
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**Summary of Findings**

1. A joint Desert Locust survey was carried out in Baluchistan of the I.R. Iran and Pakistan. The survey team was composed of two Locust Officers each from the I.R. Iran and Pakistan and one FAO Locust Officer. The survey covered a total of 5,600 km by ground in 25 days.
2. Based on the forecasts and warnings provided by FAO, both countries were on full alert and had increased the number of staff and resources in Baluchistan this year as well as initiating surveys one month earlier than usual.
3. All areas surveyed were found to be dry due to unusually low rainfall this year, except for one area of the interior of Baluchistan in Pakistan which received three successive falls of rain. Small patches of green vegetation were observed in this area.
4. No significant locust populations were detected during the survey in any area of Baluchistan. However, isolated adults and hoppers were seen at a few locations along the coastal plains of the I.R. Iran and Pakistan. Isolated hoppers were also seen in one area of Baluchistan in Pakistan where it had rained.
5. Consequently, there is little threat of a significant population build-up in Baluchistan of the I.R. Iran and Pakistan this year that could affect the Indo-Pakistan summer monsoon breeding areas.
6. Furthermore, as ecological conditions are unfavourable and are expected to become even drier since it is the end of the rainy season, any locusts arriving from the west are expected to pass through Baluchistan of the I.R. Iran and Pakistan and continue to the Indo-Pakistan summer monsoon breeding areas.

**Summary of Recommendations**

1. Due to the uncertain situation in the Arabian Peninsula, surveys should continue in the coastal and interior areas of Baluchistan in the I.R. Iran and Pakistan until the end of June in order to keep these areas under observation and detect any eastward migration towards the Indo-Pakistan summer monsoon breeding areas.
2. Results of future Desert Locust surveys should be recorded on the FAO Desert Locust Survey Form and immediately transmitted to the national plant protection headquarters and to FAO Rome.
3. The joint border survey should be repeated again in 1996 and thereafter on a regular annual basis.
4. The survey in 1996 should start on about 7 April for 15 days in Pakistan followed by 10-15 days in the I.R. Iran.
5. In future surveys, only Locust Officers should cross the border at Mirjaveh/Taftan. Host countries should provide air-conditioned 4WD vehicles, drivers and survey and camping equipment during surveys in their own country.
6. Surveys should be undertaken from about 0600-1200 hr, followed by a rest and resumed again from 1500-1900 hr.
7. In Pakistan, District Locust Officers should be more involved during surveys within their district and meet the survey team as they enter the district.
8. Per diem rates should be the same for both teams.
9. Survey funds and per diem for each team should be disbursed by the respective FAO Representations; for example, FAO/Islamabad to disburse per diem only to the Pakistan team to cover the full length of the survey; the same for FAO/Tehran.

**Acknowledgements**

The authors would like to express their sincere gratitude to the assistance and support provided by the Governments of the I.R. Iran and Pakistan as well as the Plant Protection Organization of the I.R. Iran, the Department of Plant Protection in Pakistan and the FAO Representations in both countries.

**Joint Border Survey of the Spring Breeding Areas of the Desert Locust  
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**Introduction**

During the 1960s and 1970s, Desert Locust surveys were commonly carried out in the Baluchistan border area of the I.R. Iran and Pakistan jointly by teams from both countries. The last such survey was undertaken in the spring of 1977. The purpose of these surveys was to assess the locust situation by making a survey in the border areas where regular surveys normally are not carried out by both countries.

The 19th Session of the FAO Commission for Controlling the Desert Locust in the Eastern Region of its Distribution Area in Southwest Asia recommended that a joint survey be organised from 20 April to 15 May 1995 in the I.R. Iran and Pakistan. The Session also expressed its desire that, with the undertaking of this joint survey, similar surveys should be carried out on a regular annual basis.

The purpose of a joint survey is to assess the Desert Locust situation in the border areas of the two countries using ground teams from both countries. Although regular surveys are undertaken in Baluchistan of the I.R. Iran and Pakistan by the Plant Protection Departments in each country, there is a need for supplementary surveys in some of the strategically important and less accessible areas which might not otherwise be adequately surveyed. Results from the joint survey can be used to determine the threat from the area of locust migration towards the desert areas along the Indo-Pakistan border, the scale of such migration and the subsequent breeding that might be expected during the summer monsoon period.

The Baluchistan region of the I.R. Iran and Pakistan is a traditional winter-spring breeding area for the Desert Locust (Fig. 1). In most years, locust adults gradually enter the area from the east on the prevailing easterly and north-easterly winds during October and November. These adults are a result of breeding in the desert along the Indo-Pakistan border during the summer monsoon. Upon arrival in Baluchistan, the adults usually overwinter and do not start to breed until the spring, once the seasonal rains occur and when temperatures warm-up.

The extent of the winter-spring breeding depends on the rains during the winter and spring. For example, if rainfall occurs on the coast of Baluchistan in early winter, laying may take place during December and January and hoppers are likely to hatch in February and fledge in April. If rains occur in the interior during the spring, laying is likely to occur in February and March, becoming progressively later as one moves further north. In most years, breeding usually occurs in Baluchistan during the months of March and April. Obviously if there are no rains, successful breeding is unlikely.



Figure 1. The Baluchistan area of the I.R. Iran and Pakistan.

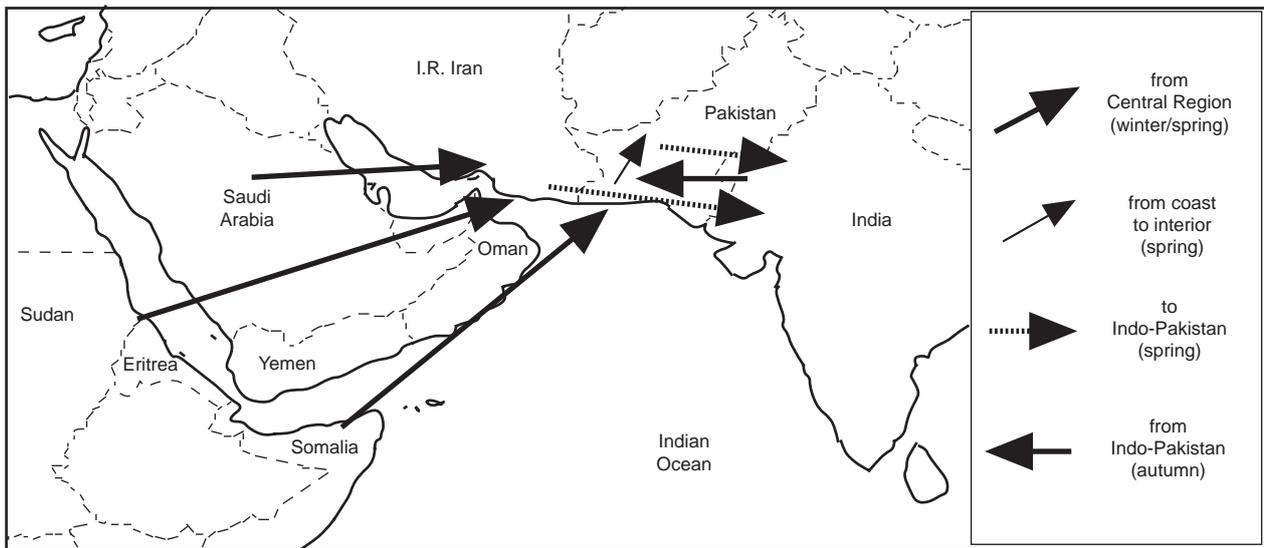


Figure 2. General migration routes of Desert Locust adults into and out of Baluchistan of the I.R. Iran and Pakistan.

From March onwards, there is usually a general increase in adult numbers in the interior of Baluchistan. Adults are carried from the coast through the valleys and across the coastal mountain ranges towards the interior by warm southerly and south-westerly winds. These winds tend to occur ahead of eastward moving low pressure systems (or depressions). This movement occurs primarily in the spring as temperatures rise and vegetation dries out earlier on the coastal plains than in the interior valleys. However, this movement may also occur in the winter but only during warm spells; otherwise, temperatures are too cold to allow flight.

Rains usually end in Baluchistan by March or April. However, if rains do fall beyond April, breeding can continue in the interior valleys during May and June.

By the end of April, temperatures in Baluchistan quickly start to rise and the humidity usually drops. Consequently, rapidly maturing adults from spring breeding leave Baluchistan from late April onwards if there has been no previous rains or from mid May onwards if there has been late rainfall (Fig. 2). These adults move east-northeast towards the western part of Sind Province in Pakistan on south-westerly monsoon winds or east-southeast to the Makran coast and then to Tharparkar via Las Bela if winds are from the north-west. The latter generally occurs when the weather is unusually hot and dry and Baluchistan is suffering from a heat wave.

Occasionally, additional adults can arrive into Baluchistan from outside the Region. This usually occurs in autumn or in winter and spring. During autumn, locusts originating from summer breeding areas of Eastern Africa and Arabia may reach south-western Iran and move further east into Baluchistan. From January to May, locusts originating from winter or early spring breeding in Eastern Africa and Arabia may arrive in Baluchistan from the west or south-west. If unusually heavy rains have fallen in Baluchistan during the winter or spring, or if rains continue until the end of spring, these immigrant adults may breed. Otherwise, they may only move through the area on their way to the Indo-Pakistan summer monsoon breeding area.

This year both countries were on full alert and had increased the number of staff and resources in Baluchistan as well as initiating surveys one month earlier than usual based on the forecasts and warnings provided by FAO of a possible invasion from the Arabian Peninsula during the spring and early summer.

### Survey Methodology

The survey team consisted of four Toyota Hi-Lux four wheel-drive vehicles: two from the I.R. Iran and two from Pakistan. Two Locust Officers and two drivers participated from the I.R. Iran and two Locust Officers, two drivers and one assistant participated from Pakistan. Each country designated a team leader who was responsible for the survey, logistics and accommodation in his own country. One Locust Officer from FAO Headquarters in Rome joined the team (Appendix 1).

Each country carried their own cooking and camping equipment, meteorological equipment, compass and maps of 1:1 million scale. The FAO Locust Officer provided a hand-held geographic positioning system (GPS) for determining the latitude and longitude of each survey stop to the nearest 100 m using satellites. FAO also provided maps of 1:500,000 scale

Throughout the survey, vehicles drove together. In the lead vehicle was the team leader from the host country, followed by two vehicles from the guest country with the last vehicle of the host country bringing up the rear. As a result, delays at security posts were minimised and the team did not become separated during the survey or in transit.

During the survey, both teams followed the FAO recommended method of survey as detailed in the FAO Desert Locust Guidelines II. Survey. This method involves stopping in areas of green vegetation, areas where recent rainfall had occurred, areas of traditional breeding and in areas identified by the local inhabitants. The survey route was determined by topography, the availability of dirt tracks, the location of traditional locust areas, and the planned overnight stop.

At each survey site, the five Locust Officers walked about 200-400 m in different directions, counting any locust adults that flew up in a one metre wide strip and examining 10-20 bushes or one square metre samples for hoppers. One team member also made weather observations and all team members noted the conditions of the habitat and estimated the area of infestation, usually based on the area of green vegetation.

The following information was collected by each Locust Officer and recorded on the FAO Desert Locust Survey Form (Appendix 2):

- Survey location
- Locust presence
- Locust appearance
- Locust behaviour
- Locust maturity
- Locust density and size
- Ecology

### Survey Results

The team surveyed the following areas in the I.R. Iran on 23 April to 1 May: (1) the south-eastern coastal plains from the Pakistan border west to Jask, (2) the interior plains of Iranshahr, and (3) the valleys of Saravan and adjacent areas. In Pakistan, the team carried out surveys on 1-9 May in: (1) Nushki, Kharan and Panjgur districts of the interior, (2) Turbat, Gwadar and Pasni districts of the coast, and (3) the Las Bela valley. Observations were made along the route in between the above areas (Fig. 3). A total of 2,810 km were covered in the I.R. Iran and 2,815 km in Pakistan (Fig. 4).



Figure 3. Route of the 1995 joint Desert Locust survey in Baluchistan of the I.R. Iran and Pakistan.

<u>Date</u>	<u>Location</u>	<u>Km</u>	<u>Date</u>	<u>Location</u>	<u>Km</u>
18-22 Apr	Pakistan team arrives in Chabahar	—	1-May	Taftan - Dalbandin	300
23-Apr	Chabahar - Gwatar	320	2-May	DAIbandin - Nushki - Quetta	450
24-Apr	Chabahar - Zaribad - Jask	390	3-May	Quetta - Nushki - Kharan	340
25-Apr	Jask - Zaribad	280	4-May	Kharan - Panjgur	330
26-Apr	Zaribad - Chahabar - Bampur	650	5-May	Panjgur - Turbat	270
27-Apr	Bampur - Iranshahr - Saravan	450	6-May	Turbat - Gwadar	230
28-Apr	Saravan - Suran - Zaboli	290	7-May	Gwadar - Pasni - Turbat	300
29-Apr	Saravan - Khash - Zahedan	330	8-May	Turbat - Awaran - Uthal	475
30-Apr	Zahedan	—	9-May	Uthal - Karachi	120
1-May	Zahedan - Mirjaveh - Mila 72	100	10-May	Karachi	—
			11-15 May	I.R. Iran team returns to Iran	—
total km in I.R. Iran		2,810	total km in Pakistan		2,815
			total km during survey		5,625

Figure 4. Itinerary and kilometres surveyed during the 1995 joint Desert Locust survey.

(a) Desert Locust

No significant locust infestations were detected during the survey in any of the above areas. However, isolated maturing adults and early instar hoppers were seen at a few locations in drying vegetation along the coastal plains of the I.R. Iran and Pakistan. Isolated early instar hoppers were also seen in one area of the interior of Baluchistan in Pakistan in green vegetation where it had previously rained. The detailed results of the survey are presented on the completed survey forms in Appendix 3.

(b) Habitat

In general, all coastal and interior areas surveyed were found to be dry. Vegetation in most areas surveyed consisted primarily of dry bushes and grasses. The state of perennial vegetation varied from green to becoming dry. Green annual vegetation was nearly non-existent except in those areas where rains had fallen within the past four weeks. In this case, sprouting vegetation was observed. However, these areas were limited in size and rare in occurrence. The only area of any significant vegetation was in one part of the interior of Baluchistan in Pakistan which extended from Nushki to south of Kharan. This area received three successive falls of rain: the end of February, late March and mid April. Consequently, small patches of green vegetation were observed.

The main potential habitats, given rain, for Desert Locust are distributed along the coastal plains and the interior plains and valleys of Baluchistan in the I.R. Iran and Pakistan. In the I.R. Iran, the primary habitats along the coast are (1) a narrow coastal strip from Chabahar east to Bris, (2) the Veshnam Plains north-east of Chabahar, (3) the Kahir area, and (4) the dune area south-east of Zaribad at Kaiki-Darak. In Pakistan, the main coastal habitats are along the plains between Gwadar and Pasni and to a lesser extent further west near Jiwani. In the interior of Baluchistan in the I.R. Iran, the primary locust habitats are the Iranshahr Plains and to a lesser extent three valleys near Saravan. In the interior of Pakistan, the main habitats are: (1) the high plains from Dalbandin to Nushki, (2) the Kharan Valley, (3) the Baluchistan Desert, and (4) the Dasht area of Turbat. There are smaller more confined areas in the Panjgur Valley and west of Turbat. In general, the habitats on the coastal and interior plains are widespread whereas those in the mountain valleys are limited to areas near the seasonal rivers ("wadi" in English, "kaur" in Urdu, "rudkhaneh" in Farsi). Detailed habitat observations are presented in Appendix 4.

(c) Weather

Throughout the survey, the weather was generally hot and dry. Daytime temperatures on the coast varied from 29 to 42°C and in the interior from 17 to 38°C during the period. Humidity was generally higher in coastal areas than in the interior. A low pressure system moved eastwards along the southern coast of the I.R. Iran on 23-25 April. As a result, strong easterly winds ahead of the system prevailed on the 23rd and 24th. This was followed by light rains on the coast and moderate rainfall in the coastal mountains on the 24-25th. Light rainfall and cool temperatures occurred one day during the survey at Saravan, I.R. Iran on the 28th. By the end of the survey, temperatures were rapidly increasing in coastal and interior areas of Baluchistan in Pakistan. Meteorological observations are summarised in Appendix 5.

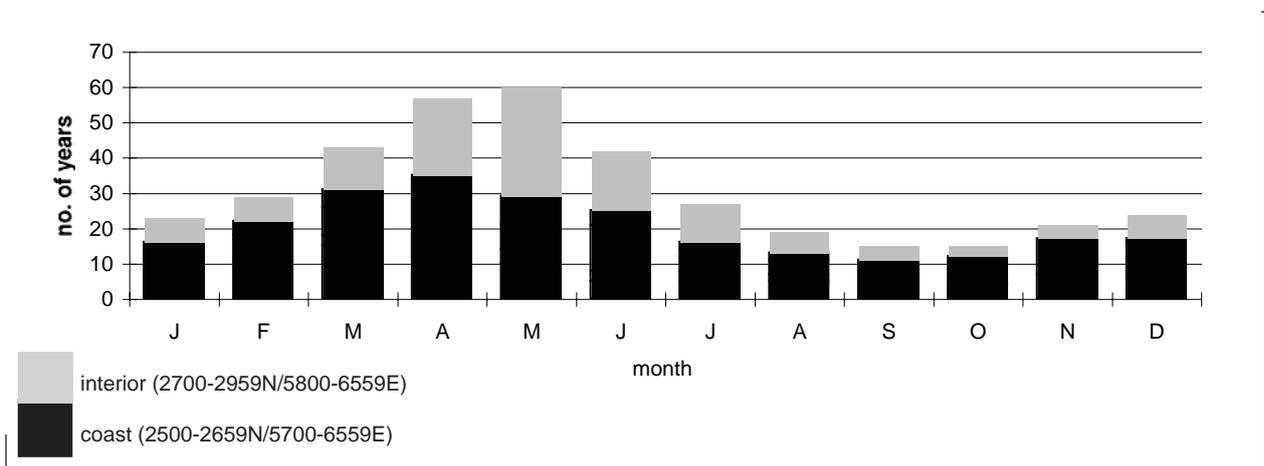


Figure 5. The maximum number of years in which there was at least one report of locusts during the specified month in the coastal and interior of Baluchistan during 1939-1985. (source: FAO/ECLC)

## Discussion

### (a) Locust situation

Although Baluchistan is not commonly considered a source area responsible for the development of locust upsurges and plagues, locust numbers can increase substantially in years when the conditions are optimum. In those years when ecological conditions and seasonal rainfall are only average, locust populations are usually present to some degree on the coast and to a lesser degree in the interior of Baluchistan (Fig. 5). Examining this further, it can be seen that in the past locust infestations were generally more prevalent on the coast and in the interior of Baluchistan in Pakistan rather than in the I.R. Iran (Fig. 6). This may be a result of the former areas being closer to the Indo-Pakistan summer breeding areas. It is also worthwhile to note that the frequency of locust infestations in Baluchistan is highest during the spring although there have been infestations present during other months of the year as well.

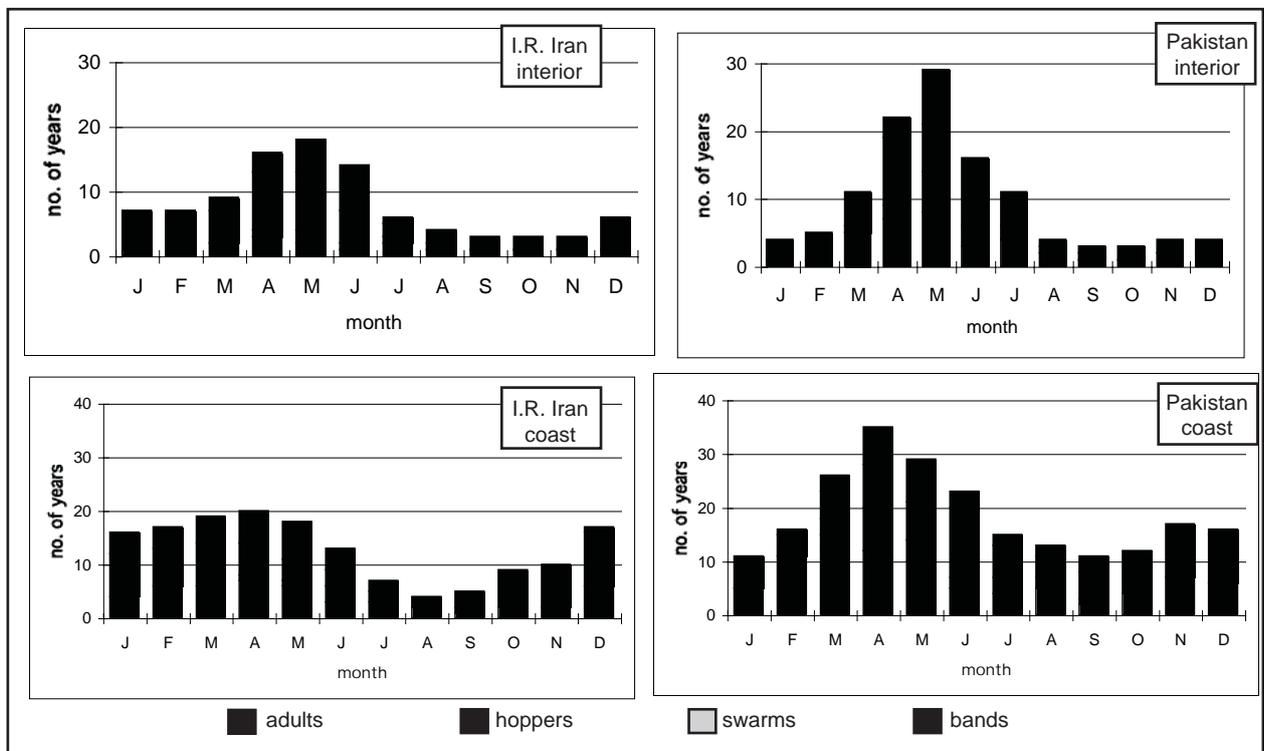


Figure 6. A comparison of the frequency of locust infestations in coastal and interior areas of Baluchistan in the I.R. Iran and Pakistan during 1939-1985. [note: swarms and bands 1939-1963, adults and hoppers 1963-1985] (source: FAO/ECLC)

Swarms were last reported in Baluchistan in July 1993 (Pakistan) and November 1993 (I.R. Iran). Small control operations were undertaken in 1981, 1989-91, and 1993.

During the joint survey this year in Baluchistan, all areas surveyed were found to be dry and very few locusts were seen (Fig. 7). These results can be attributed to two primary factors: (1) unusually low rainfall that occurred this year and (2) very low source populations present in Baluchistan.

In most coastal and interior areas of Baluchistan, seasonal rainfall this year was well below long term averages (Fig. 8). Consequently vegetation was found to be dried than normal and there was an absence of soil moisture in most places. Hence, conditions were not favourable for locust breeding and, in fact, not favourable for locust survival. The only exception to this was in one area of the interior of Baluchistan (Kharan and Nushki districts) in Pakistan which received three successive falls of rain and small patches of green vegetation were observed. Yet even here very few locusts seemed to be present to take advantage of such favourable conditions. This can be explained by very few locusts arriving from the Indo-Pakistan breeding areas of the previous summer late last year.

Despite the overall poor breeding conditions, some limited breeding occurred in a few isolated areas of Baluchistan, namely the central coast of the I.R. Iran (Zaribad) and Pakistan (Gwadar) and in the interior (Kharan district of Pakistan). Isolated breeding was also reported in the Pasni district and is expected to have occurred in the Nushki district although this has not been reported to date.

Nevertheless, it must be clearly emphasized that breeding this year has been extremely limited in the traditional areas of Baluchistan of the I.R. Iran and Pakistan. Hence, there is little threat of a significant population build-up in these areas this year that could affect the Indo-Pakistan summer monsoon breeding areas.

As it is the end of the rainy season in Baluchistan, vegetation is expected to continue to dry out and conditions will become even less favourable for breeding as temperatures rise. Therefore, any locusts arriving from the west are expected to pass through Baluchistan of the I.R. Iran and Pakistan and continue to the Indo-Pakistan summer monsoon breeding areas. No further breeding is expected this year in Baluchistan.

Due to the uncertain situation in the Arabian Peninsula, the team recommends that surveys continue in the coastal and interior areas of Baluchistan in the I.R. Iran and Pakistan until the end of June in order to keep these areas under observation and detect any eastward migration towards the Indo-Pakistan summer monsoon breeding areas. Locust survey results should be recorded on the FAO Desert Locust Survey Form and immediately transmitted to national headquarters and to FAO Rome.



Figure 7. Results of the 1995 joint Desert Locust survey (x = adults, o = hoppers).

Month	Chabahar		Gwadar	Pasni	Uthal	Karachi		Turbat	Panjgur	Kharan	Nushki *	
	1995	avg	1995	1995	1995	1995	avg	1995	1995	1995	1995	avg
January	0	49	0	0	0	89	7	0	3	0	0	25
February	32	17	0	44	5	57	11	0	1	0	20	18
March	0	6	5	8	tr	0	6	6	5	13	42	12
April	n/a	2	0	0	6	0	2	0	0	8	48	5

\* Dalbandin average rainfall  
avg = average rainfall during 1930-1961 (source: FAO)      tr = trace      n/a = not available

Figure 8. Rainfall reported in 1995 compared to long term averages.

(b) 1996 joint border survey

The team strongly recommends that a joint border survey be repeated again in 1996 and thereafter on a regular annual basis in Baluchistan during the spring. The objectives and advantages of such surveys have already been discussed in earlier sections.

Although the dates of future surveys should correspond to when locusts are most likely to be present and after seasonal rains have occurred, the survey in 1996 should probably start about 7 April for 15 days in Pakistan followed by 10-15 days in the I.R. Iran.

During the current survey, many lessons were learned that should be applied to future surveys to make them more effective as well as easier to organize and implement. These lessons are summarised below as recommendations for future surveys.

- (i) Only Locust Officers should cross the border at Mirjaveh/Taftan. Host countries should provide air-conditioned 4WD vehicles, drivers and survey and camping equipment during surveys in their own country;
- (ii) Surveys should be undertaken from about 0600-1200 hr, followed by a rest and resumed again from 1500-1900 hr;
- (iii) In Pakistan, District Locust Officers should be more involved during surveys within their district and meet the survey team as they enter the district;
- (iv) Per diem rates should be the same for both teams; and
- (v) Survey funds and per diem for each team should be disbursed by the respective FAO Representations; for example, FAO/Islamabad to disburse per diem only to the Pakistan team to cover the full length of the survey; the same for FAO/Tehran.

A proposed itinerary for the joint border survey in 1996 is presented in Appendix 6.

## **Appendix 1. Survey participants**

### **I.R. Iran**

Mir Hossain SANJARANI, Team Leader  
Farzad Kalantar HORMOZI, Locust Officer  
Mehrab JAWAM, Driver  
Ali Akbar NATEGHI, Driver

### **Pakistan**

Zafar ALI KHAN, Team Leader  
Iftikhar AHMED, Locust Officer  
Mohamed MAGBOL, Assistant  
Muzayyen SHAH, Driver  
Mohamed HUSSEIN, Driver

### **FAO**

Keith CRESSMAN, Locust Forecasting Officer



**Appendix 2.**

**DESERT LOCUST SURVEY FORM**

send completed form to FAO HQ by fax (0039) 6 - 522 -55271 and

	1-1	1-2	1-3	1-4	1-5	1-6	1	2	3	4	5	6
1. LOCA-	survey stop											
	date											
	name											
	latitude (°N)											
	longitude (°E or W)											
	area (ha)											
2. PRESENCE	topography	<input type="checkbox"/>										
	present	<input type="checkbox"/>										
3. APPEAR-	absent	<input type="checkbox"/>										
	solitary	<input type="checkbox"/>										
4. BEHAVIOUR	transiens	<input type="checkbox"/>										
	gregarious	<input type="checkbox"/>										
	copulating	<input type="checkbox"/>										
	laying											
	hatching											
5. MATURITY	settled	<input type="checkbox"/>										
	flying (direction & time passing over-head)											
6. DENSITY	flying (height & width)											
	instar or fledgling (1 2 3 4 5 6 F)											
7. ECOLOGY	immature adult											
	mature adult											
	hoppers/m <sup>2</sup> or bush											
8. CONTROL	adults/transsect or ha											
	band density (Low Medium Dense) & size (m <sup>2</sup> )											
	swarm density (Low Medium Dense) & size (km <sup>2</sup> )											
	date of last rain											
9. COMMENTS												

prepared by \_\_\_\_\_

### Appendix 3. Survey results

		1	2	3	4	5	6	
1. LOCATION	1-1	survey stop						
	1-2	date	23/4/95	23/4/95	23/4/95	24/4/95	24/4/95	
	1-3	name	Balisar	?	Beris area	Darak	Poshti	Kaikia
	1-4	latitude (°N)	2516 13	2513	2511 30	2528	2529 36	2530
	1-5	longitude (°E or W)	6047 36	6059	6105 46	5930	5927 01	5926
	1-6	area (ha)	50	80	100	45	30	80
	1-7	topography	plain + dune	sand by sea	sand by sea	sandy low dunes	low dunes	sandy
2. PRESENCE	2-1	present	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	2-2	absent	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
3. APPEARANCE	3-1	solitary	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	3-2	transiens	<input type="checkbox"/>					
	3-3	gregarious	<input type="checkbox"/>					
4. BEHAVIOUR	4-1	copulating	<input type="checkbox"/>					
	4-2	laying	<input type="checkbox"/>					
	4-3	hatching	<input type="checkbox"/>					
	4-4	settled	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	4-5	flying (direction & time passing overhead)						
	4-6	flying (height & width)						
5. MATURITY	5-1	instar of fledgling (1 2 3 4 5 6 F)					12	
	5-2	immature adult	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	5-3	mature adult	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
6. DENSITY & SIZE	6-1	hoppers/m2 or bush					1-2	
	6-2	adults/transect or ha		1/400m		2/1500m	2/450m	
	6-3	band density (Low Medium Dense) and size (m2)						
	6-4	swarm density (Low Medium Dense) & size (km2)						
7. ECOLOGY	7-1	date of last rain						
	7-2	rain amount (Low Moderate High)						
	7-3	vegetation (dry, greening, green, drying)	greening	greening	greening	greening	greening	greening
	7-4	vegetation density (Low Medium Dense)	L	M	M	M	M	M
	7-5	soil moisture (wet, dry)	W	D	D	D	D	D
8. CONTROL	8-1	pesticide name & formulation						
	8-2	application rate (l/ha)						
	8-3	quantity (l)						
	8-4	area treated (ha)						
	8-5	ground or air						
	8-6	estimated % kill						
9. COMMENTS		patches of veg; moist near dunes;				strong east wind	no DL in 2 ha sorghum farm	high wind

### Appendix 3. Survey results (cont.)

		<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>12</b>	
1. LOCATION	1-1	survey stop						
	1-2	date	25/4/95	25/4/95	25/4/95	26/4/95	27/4/95	
	1-3	name	Sorgala	Waink	Jozdar	?	R. Bent	SArdegal
	1-4	latitude (°N)	2537	2540	2546 44	2528 23	2542 45	2714 31
	1-5	longitude (°E or W)	5826	5902	5913 22	5928 25	5920 20	6025 51
	1-6	area (ha)	?	30	?	?	?	100
	1-7	topography	mud flats	sandy plain	wadi	dunes	wadi	dunes
2. PRESENCE	2-1	present	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2-2	absent	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3. APPEARANCE	3-1	solitary	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	3-2	transiens	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	3-3	gregarious	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. BEHAVIOUR	4-1	copulating	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	4-2	laying	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	4-3	hatching	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	4-4	settled	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	4-5	flying (direction & time passing overhead)						
	4-6	flying (height & width)						
5. MATURITY	5-1	instar of fledgling (1 2 3 4 5 6 F)						
	5-2	immature adult	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	5-3	mature adult	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. DENSITY & SIZE	6-1	hoppers/m2 or bush						
	6-2	adults/transect or ha						
	6-3	band density (Low Medium Dense) and size (m2)						
	6-4	swarm density (Low Medium Dense) & size (km2)						
7. ECOLOGY	7-1	date of last rain	24/4/95	24/4/95			23/4/95	
	7-2	rain amount (Low Moderate High)	L	L				
	7-3	vegetation (dry, greening, green, drying)	none	greening	greening	dry	dry	dry/greening
	7-4	vegetation density (Low Medium Dense)		L	L			L
	7-5	soil moisture (wet, dry)	W	W	D	D	D	W
8. CONTROL	8-1	pesticide name & formulation						
	8-2	application rate (l/ha)						
	8-3	quantity (l)						
	8-4	area treated (ha)						
	8-5	ground or air						
	8-6	estimated % kill						
9. COMMENTS		not suitable - mud flats		hopper bands in spring 1991 + 1994	control 7000 ha in 1990	R. Bent flowing + flooded from rains in mountains on 25/5/95	control in 1990	

### Appendix 3. Survey results (cont.)

		<b>13</b>	<b>14</b>	<b>15</b>	<b>16</b>	<b>17</b>	<b>18</b>	
1. LOCATION	1-1	survey stop						
	1-2	date	27/4/95	27/4/95	27/4/95	28/4/95	28/4/95	
	1-3	name	central Sardegna	Shams Abad	Korehaimemari	Shandon	N. Sahndon	Nurabad
	1-4	latitude (°N)	2714 36	2712 36	2707 08	2722 21	2723 06	2722 55
	1-5	longitude (°E or W)	6023 45	6020 49	6041 04	6154 11	6153 39	6152 47
	1-6	area (ha)	120	60	150	30	50	10
	1-7	topography	sandy	sandy	sandy	sandy plain	sandy plain	plain + wadi
2. PRESENCE	2-1	present	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2-2	absent	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3. APPEARANCE	3-1	solitary	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	3-2	transiens	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	3-3	gregarious	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. BEHAVIOUR	4-1	copulating	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	4-2	laying	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	4-3	hatching	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	4-4	settled	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	4-5	flying (direction & time passing overhead)						
	4-6	flying (height & width)						
5. MATURITY	5-1	instar of fledgling (1 2 3 4 5 6 F)						
	5-2	immature adult	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	5-3	mature adult	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. DENSITY & SIZE	6-1	hoppers/m2 or bush						
	6-2	adults/transect or ha						
	6-3	band density (Low Medium Dense) and size (m2)						
	6-4	swarm density (Low Medium Dense) & size (km2)						
7. ECOLOGY	7-1	date of last rain	23/4/95			spring 1994	spring 1994	spring 1994
	7-2	rain amount (Low Moderate High)	L			H	H	H
	7-3	vegetation (dry, greening, green, drying)	dry/greening	dry	dry	dry	dry	greening
	7-4	vegetation density (Low Medium Dense)	L	L	L	L	L	L
	7-5	soil moisture (wet, dry)	W	D	D	D	D	W
8. CONTROL	8-1	pesticide name & formulation						
	8-2	application rate (l/ha)						
	8-3	quantity (l)						
	8-4	area treated (ha)						
	8-5	ground or air						
	8-6	estimated % kill						
9. COMMENTS		control in 1990; annuals sprouting	large dry bushes; 1990 hopper + adult control	hoppers + adults in 1981	light rain falling; hoppers in 1971	light rain falling; plains extend for 15 km north	light rain falling; veg only in wadi	

### Appendix 3. Survey results (cont.)

		<b>19</b>	<b>20</b>	<b>21</b>	<b>22</b>	<b>23</b>	<b>24</b>	
1. LOCATION	1-1	survey stop						
	1-2	date	28/4/95	5/2/95	5/3/95	5/3/95	5/3/95	
	1-3	name	Hoshab	Mandag	Riko	Gazzi	Jamak	S. Jamak
	1-4	latitude (°N)	2708 44	2859	2910 51	2830 38	2826 13	2825 48
	1-5	longitude (°E or W)	6148 27	6512	6555 22	6521 55	6518 13	6517 59
	1-6	area (ha)	60	100	55	10	20	20
	1-7	topography	plain	plain	sandy / hilly	sandy	sandy	sandy
2. PRESENCE	2-1	present	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	2-2	absent	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. APPEARANCE	3-1	solitary	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	3-2	transiens	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	3-3	gregarious	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. BEHAVIOUR	4-1	copulating	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	4-2	laying	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	4-3	hatching	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	4-4	settled	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	4-5	flying (direction & time passing overhead)						
	4-6	flying (height & width)						
5. MATURITY	5-1	instar of fledgling (1 2 3 4 5 6 F)					12	12
	5-2	immature adult	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	5-3	mature adult	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. DENSITY & SIZE	6-1	hoppers/m2 or bush					2-8/bush	1-4/bush
	6-2	adults/transect or ha				6/1600m		
	6-3	band density (Low Medium Dense) and size (m2)						
	6-4	swarm density (Low Medium Dense) & size (km2)						
7. ECOLOGY	7-1	date of last rain	2/95					
	7-2	rain amount (Low Moderate High)	H					
	7-3	vegetation (dry, greening, green, drying)	dry	greening	dry	green	green	green
	7-4	vegetation density (Low Medium Dense)	M	L	M	M	L	L
	7-5	soil moisture (wet, dry)	D	D	D	D	D	D
8. CONTROL	8-1	pesticide name & formulation						
	8-2	application rate (l/ha)						
	8-3	quantity (l)						
	8-4	area treated (ha)						
	8-5	ground or air						
	8-6	estimated % kill						
9. COMMENTS		1980 hopper + adult control	rocky		maize + water-melon crops; hot winds	copulating 8/4 before crops harvested; max 15m between bushes	continuation of wadi; infest rate 40%	

### Appendix 3. Survey results (cont.)

		<b>25</b>	<b>26</b>	<b>27</b>	<b>28</b>	<b>29</b>	<b>30</b>	
1. LOCATION	1-1	survey stop						
	1-2	date	5/3/95	5/4/95	5/4/95	5/4/95	5/4/95	
	1-3	name	Bashoor	Dali	N. Basima	Padack	Jat	?
	1-4	latitude (°N)	2827 22	2814 33	2800 35	2747 18	2720 05	2705
	1-5	longitude (°E or W)	6519 20	6541 06	6546 25	6540 45	6451 00	6421
	1-6	area (ha)	3	120	80	40	400	10
	1-7	topography	sandy	sand/rocky plain	rocky plain	wadi	dasht	dasht
2. PRESENCE	2-1	present	■	□	□	□	□	□
	2-2	absent	□	■	■	■	■	■
3. APPEARANCE	3-1	solitary	■	□	□	□	□	□
	3-2	transiens	□	□	□	□	□	□
	3-3	gregarious	□	□	□	□	□	□
4. BEHAVIOUR	4-1	copulating	□	□	□	□	□	□
	4-2	laying	□	□	□	□	□	□
	4-3	hatching	□	□	□	□	□	□
	4-4	settled	□	□	□	□	□	□
	4-5	flying (direction & time passing overhead)						
	4-6	flying (height & width)						
5. MATURITY	5-1	instar of fledgling (1 2 3 4 5 6 F)	1					
	5-2	immature adult	□	□	□	□	□	□
	5-3	mature adult	■	□	□	□	□	□
6. DENSITY & SIZE	6-1	hoppers/m2 or bush	1/bsuh					
	6-2	adults/transect or ha	1					
	6-3	band density (Low Medium Dense) and size (m2)						
	6-4	swarm density (Low Medium Dense) & size (km2)						
7. ECOLOGY	7-1	date of last rain						
	7-2	rain amount (Low Moderate High)						
	7-3	vegetation (dry, greening, green, drying)	green	dry/greening	green	green	green	green
	7-4	vegetation density (Low Medium Dense)	M	L	L	M	M	L
	7-5	soil moisture (wet, dry)	D	D	D	W	D	D
8. CONTROL	8-1	pesticide name & formulation						
	8-2	application rate (l/ha)						
	8-3	quantity (l)						
	8-4	area treated (ha)						
	8-5	ground or air						
	8-6	estimated % kill						
9. COMMENTS		small veg patch; one adult only; infest rate 4%	adjacent hills		adjacent hills	1990 control of solitary local breeding L12 + adults	veg patch surrounded by gravel plain	

### Appendix 3. Survey results (cont.)

		<b>31</b>	<b>32</b>	<b>33</b>	<b>34</b>	<b>35</b>	<b>36</b>	
1. LOCATION	1-1	survey stop						
	1-2	date	5/6/95	5/6/95	5/6/95	5/6/95	5/6/95	
	1-3	name	Bandgah	Beri Chaht	Shooli	Chati	Bishooli	Shooli
	1-4	latitude (°N)	2553 23	2543 05	2539	2537 19	2538 28	2534 18
	1-5	longitude (°E or W)	6245 02	6237 19	6222	6214 57	6208 46	6207 04
	1-6	area (ha)	30	20	30	?	?	10
	1-7	topography	plain	sandy plain	sandy valley	wadi	sandy plain	sandy depression
2. PRESENCE	2-1	present	<input type="checkbox"/>	<input checked="" type="checkbox"/>				
	2-2	absent	<input checked="" type="checkbox"/>	<input type="checkbox"/>				
3. APPEARANCE	3-1	solitary	<input type="checkbox"/>	<input checked="" type="checkbox"/>				
	3-2	transiens	<input type="checkbox"/>	<input type="checkbox"/>				
	3-3	gregarious	<input type="checkbox"/>	<input type="checkbox"/>				
4. BEHAVIOUR	4-1	copulating	<input type="checkbox"/>	<input type="checkbox"/>				
	4-2	laying	<input type="checkbox"/>	<input type="checkbox"/>				
	4-3	hatching	<input type="checkbox"/>	<input type="checkbox"/>				
	4-4	settled	<input type="checkbox"/>	<input type="checkbox"/>				
	4-5	flying (direction & time passing overhead)						
	4-6	flying (height & width)						
5. MATURITY	5-1	instar of fledgling (1 2 3 4 5 6 F)						
	5-2	immature adult	<input type="checkbox"/>	<input type="checkbox"/>				
	5-3	mature adult	<input type="checkbox"/>	<input checked="" type="checkbox"/>				
6. DENSITY & SIZE	6-1	hoppers/m2 or bush						
	6-2	adults/transect or ha						3/1200m
	6-3	band density (Low Medium Dense) and size (m2)						
	6-4	swarm density (Low Medium Dense) & size (km2)						
7. ECOLOGY	7-1	date of last rain					18/4/95	18/4/95
	7-2	rain amount (Low Moderate High)					M	
	7-3	vegetation (dry, greening, green, drying)	dry	green	dry	dry	green	dry/greening
	7-4	vegetation density (Low Medium Dense)	L	D			M	L/M
	7-5	soil moisture (wet, dry)	D	D	D	D	D	W
8. CONTROL	8-1	pesticide name & formulation						
	8-2	application rate (l/ha)						
	8-3	quantity (l)						
	8-4	area treated (ha)						
	8-5	ground or air						
	8-6	estimated % kill						
9. COMMENTS		band control in Mar-Apr 1989	earth dam at W. Dad Kaur	control in the past		maize crop; control in 1990	maize crop; sprouting veg; 2 adults in 200m in maize crop	

### Appendix 3. Survey results (cont.)

			37	38	39	40	41	42
1. LOCATION	1-1	survey stop						
	1-2	date	5/7/95	5/7/95	5/7/95	5/7/95	5/9/95	5/9/95
	1-3	name	Zariat Machi	Juri	Kapar	Kandasole	Wingoa	Tinkanda
	1-4	latitude (°N)	2515 23	2517 40	2519 09	2522 54	2538 15	2531 35
	1-5	longitude (°E or W)	6224 42	6235 58	6242 03	6300 32	6636 32	6639 04
	1-6	area (ha)	30	20	50	25	500	?
	1-7	topography	sand/clay plain	sand/clay plain	sand/clay plain	sandy valley	flat sandy	flat sandy
2. PRESENCE	2-1	present	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2-2	absent	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3. APPEARANCE	3-1	solitary	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	3-2	transiens	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	3-3	gregarious	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. BEHAVIOUR	4-1	copulating	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	4-2	laying	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	4-3	hatching	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	4-4	settled	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	4-5	flying (direction & time passing overhead)						
	4-6	flying (height & width)						
5. MATURITY	5-1	instar of fledgling (1 2 3 4 5 6 F)			13			
	5-2	immature adult	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	5-3	mature adult	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. DENSITY & SIZE	6-1	hoppers/m2 or bush			1-2/bush	1/1200m		
	6-2	adults/transsect or ha						
	6-3	band density (Low Medium Dense) and size (m2)						
	6-4	swarm density (Low Medium Dense) & size (km2)						
7. ECOLOGY	7-1	date of last rain	mid 3/95					
	7-2	rain amount (Low Moderate High)	L-M					
	7-3	vegetation (dry, greening, green, drying)	green	dry	drying	drying	dry	dry
	7-4	vegetation density (Low Medium Dense)	L	L	L	L	D	D
	7-5	soil moisture (wet, dry)	D	D	D	D	D	D
8. CONTROL	8-1	pesticide name & formulation						
	8-2	application rate (l/ha)						
	8-3	quantity (l)						
	8-4	area treated (ha)						
	8-5	ground or air						
	8-6	estimated % kill						
9. COMMENTS			young maize crop; five L12 hoppers on 17/5	Barl (hindu) tree	total of 3 hoppers seen; infest rate 10%	Popov gregarization area	7/93 breeding by incoming swarms	7/93 breeding by incoming swarms; area 30 by 25 km

## **Appendix 4. Habitat observations**

*[note: the term wadi is used to indicate a seasonal river which fills up with water after rains but otherwise remains dry during the year; the closest equivalent is rudkhaneh in Farsi and kaur in Urdu). In some cases, abbreviations are used: W, R, K, respectively.]*

### **Chabahar - Gwatar**

Leaving Chabahar east along the coast, the asphalt continues about 10 km before turning into a dirt track. The area is barren except for some dry shrubs (*Tribulus* sp., saltbrush and grass species) amongst the low cliffs to the north and sand dunes south towards the sea. Eventually the terrain becomes more ruddy and the road falls into two deep gorges and up the other side. Both gorges have villages consisting of few cement block huts and palms in the riverbed. The interior hills are extremely eroded. In between, shallow salt marshes appear, more significantly on the inland side. Low sand dunes with dry vegetation about one km wide extend up and down the coast between the sea and the track. After about 20 km, the asphalt returns opposite a lonely tented police post. The hills continue to be barren and become less jagged and start to flatten out closer to the fishing village of Bris. Ras Zarrin Sar can be seen sticking out into the sea from a long way.

After Bris, the road climbs up to a flat rocky plateau with cliffs dropping straight to the sea, similar to southern area of Ras Al- Hadd (Oman). The road drops to the sea near a small village and then climbs to another plateau until the police post at the end of the road at Gwatar. From here, the village of Jiwani (Pakistan) can be seen across the Gwatar Bay. Inland is a Hara forest (mangroves) in the swamps along the north shore.

Returning inland, a dirt track crosses a large flat hard clay plain suitable for aircraft landing strips. The plain is broken occasionally by a few saltbrush bushes and more often by mirages of distant lakes. The first village is Sammach where there are signs of rain-fed agriculture, mostly sorghum. The asphalt road is here and following this past increasing amounts of vegetation to the village of Negur and on towards the main Chabahar/Iranshahr road. This road goes through rough terrain and low hills, coming out onto the hot and dusty Veshnam plains sloping down towards the sea with a few small plots of rainfed agriculture. The backside of the Chabahar cliffs are on the horizon.

Therefore, the main area east of Chabahar to the border suitable for Desert Locust is along a narrow coastal strip to Bris and in the interior on the Veshnam Plains, primarily in the rain-fed sorghum plots.

### **Chabahar - Zaribad**

The road passes north of the airport across a dusty plain with visibility nearly to zero due to a very strong easterly wind and blowing dust. Rain in the mountains the previous night caused the two main wadis between Chabahar and Kahir to temporarily flow: a small narrow and deep wadi, R. Sarganat, behind the air base and further west after about one hour, R. Nikshahr close to the foothills at Kahir oasis. The landscape in between is fairly featureless with a few clumps of trees breaking up the monotony. Tropical fruits (banana, mango, papaya, meddler, etc.) are grown in Kahir oasis.

The road continues westwards along the south side of the coastal mountains which, in some places, rise abruptly from the plain. Several small wadis cut into the plain and head towards the sea. The plain becomes dissected giving way to rougher more irregular terrain. Turning towards the sea, sand dunes and sandy plains and valleys are first seen near the small village of Darak. Given rainfall, this sandy area which continues west along the coast and becomes sandier with more low dunes cut by wadis would be a good breeding area. Inland from this area is a large oasis with rain-fed sorghum plots known as Zaribad. It is difficult to retain a sense of direction due to the dissected nature of the terrain, poor visibility, numerous tracks and roads that curve and not being able to see the sea.

South-east of Zaribad, the terrain becomes broken by small riverines, gullies and hills. Along the coast are dunes with dry vegetation but a very good locust area if rains fall. In 1990, 7000 ha were treated in this area. The old road along the shore is covered by dunes and very tough going - very easy to get stuck in the soft moving sand. Inland, it is rocky with hills and canyons. Then the flat plains return: wide and say with buttes and mesas to the north. The plain is long and interrupted by a few small wadi cuts without vegetation.

## **Zaribad - Jask**

After passing some rain-fed sorghum plots on the edge of the oasis and crossing R. Bent, the road from Zaribad quickly becomes a raised gravel track crossing a plain of dry vegetation and low gravel hills. Vegetation (*Tribulus* sp., bushes and a few sorghum plots) appears outside the first village, Suru, as well as lines of trees on the horizon. This is followed by an increasing number of small oases at the base of the coastal foothills. There are three large wadis which are deep and their trees could be seen from the distance along the plains: Sedich, Gabrik, and Jaghin. In between R. Gabrik and R. Jaghin, there were smaller wadis with many branches. The foothills along this stretch are very jagged. Beyond the oases, the plains are flat with trees and bushes - not a very good locust area. Traversing the coastal plain from the mountains to the sea west of Gabrik is a dull affair: only groves of trees, thinning out to great expanses of barren flats which become muddy near the coast. Not a locust area.

The last wadi (R. Jaghin) was flowing fast from rain during the past 24 hr (24 April) in the mountains to the north. After R. Sedich, there are low dunes of very white fine sand, some covering the road. After R. Jaghin, there is a flat dull plain of sand/gravel with dry scrub brush. Where the mountains touch the sea is the fishing village of Jask, surrounded by the Oman sea on three sides.

Evidence of widespread light rains was seen along the coast from Chabahar to Jask at several spots, primarily on the western plains, which probably fell the evening of 24 April. As a result of heavier rains in the mountains to the north, the wadi west of Zaribad, R. Bent, was flowing swiftly and could not be crossed until the next morning. Nevertheless, the coastal plains are much drier than usual due to poor rains. In 1994, there was more rain and vegetation than this year.

## **Coastal summary**

The main Desert Locust areas, given adequate rainfall, are: (1) a narrow coastal strip east of Chabahar to Bris, (2) the Veshnam Plains north-east of Chabahar, (3) the Garok/Kahir area east of Chabahar, and (4) the dune area on the central plains south-east of Zaribad at Kaiki and Darak. The remainder of the coastal plains to Jask is poor. The major wadis are east to west are: Sargan, Kahir, Bent, Sedich, Gasrik, and Jaghin.

## **Chabahar - Iranshahr**

The road climbs out of Chabahar to the Veshnam Plains, crossing a set of rocky hills to another dry sandy plain with tree lines associated with R. Dashtiari on the eastern horizon. Upon reaching the foothills of the coastal range, the road follows a long increasingly narrow valley full of oases. The terrain becomes more and more mountainous and the vast oases become smaller and less numerous along R. Bahu-Kalat. The Pishin Dam to the east is not visible. The first pass is over a treeless, rocky set of hills. On the other side is the Ghor Lashar river valley followed by another set of mountains to Rask, known for its oranges. The road continues along mountain valleys and twists and turns until about 20 km from Iranshahr where it drops down into the plains. Up to this point, the area is not suitable for locusts except as a transit passage from the coast to the interior.

## **The Iranshahr Plains**

If enough rains occur, locusts could potentially be distributed over a large and widespread area of the Iranshahr Plains. In the past, the infestations have been confined to one contiguous area west of Iranshahr known as Sardigal and Shamsabad as well as south of the city in a dune area. Both areas are sandy plains with dunes, the latter more so while the former is broken up by a few shallow wadis. Both contain large perennial shrubs and smaller annuals. Control operations were undertaken here in 1981. The mountains to the north, east, and south are not visible unless it is clear. Much further to the west are other potential locust breeding areas at Jazmuriyan but surveys are difficult due to occasional insecurity.

### **Iranshahr - Khash - Saravan**

Leaving the Iranshahr plains, mountains to the north shortly come into view. The road follows the Karwandar Valley with some oases and small villages. A series of mountain ranges that form the Kuh-Varzan are crossed: stunningly jagged in colours from tan to blue to grey. These are separated by deep gorges. More mountains on the horizon. Just before Khash, the large high valley of Hamun-Chah-Gau consisting of dry scrub brush surrounded by mountains is crossed. Then Khash appears below in a valley against an impressive backdrop of the Kuh-Haye-Sarhad mountains.

In this area of Baluchistan, there are three main valleys that run northwest-southeast separated by rocky barren treeless mountain ranges. The Saravan Valley, the eastern most valley, is primarily a dry gravel plain with some sandy-clay areas and a few wadis. There is no green vegetation in sight except on the southern edge of Khash where small green bushes (*Plantago* sp, barhank) and other green vegetation are present. North of Gasht, scattered wild pistachio (*banaa*) trees appear. Gasht itself is a small oasis up against the eastern range of the Kuh-Haye-Sarhad mountains. Otherwise, vegetation consists of dry scrub brush. On the northern edge of Saravan sandy areas and date palms appear.

### **Saravan - Suran - Zaboli**

West of Saravan is a low set of rocky, barren hills followed by a plain similar to that of Saravan Valley but smaller. The few villages in the area are oases. Suran for example grows dates and wheat, the latter north of the village. One primary locust area is located just to the east of the wheat plots and extends for about 15 km north. The area is sandy-clay with low sandy hills and dry brush.

The next valley west is similar with confined areas of sand and vegetation suitable for locusts. However, without rain, these areas are very dry. Hence, these valleys are suitable for breeding but on a limited and localised scale. Locust could threaten the export crops of the area: wheat and date palms (for export). Apart from the palms and some cypress-like trees, the valleys and especially the mountains are devoid of trees. Average elevation of the valleys is about 1000 m plus.

### **Khash - Zahedan**

Khash, at an elevation of 1,500 m, has many pine trees and is surrounded by mountains to the north-east and south-west plus the tall volcanic Taftan Peak (3,944 m) further north.

North of Khash, a number of low hills of scrub brush and small high arid plains are crossed west of Mt. Taftan towards Zahedan. Several small walled plots of fruit trees in one area appear very green against the brown landscape. A few larger barren valleys appear surrounded by mountains. However, the area from Khash to Zahedan is not very suitable for locusts due to its relatively high elevation, rocky terrain and sparse vegetation.

### **Zahedan - Mirjaveh**

Leaving Zahedan to the south-east, low hills on the edge of Zahedan Valley lead to a wide rocky plain which continues down to Mirjaveh. Bare mountains are to the north and the south and looming in the distance to the south; is Taftan Mountain. The only vegetation and potential locust area is in the Mirjaveh wadi as well as in the cereal cropping plots on the northern edge of the Mirjaveh and to the east. East of Mirjaveh towards Taftan, the plains become extremely barren and flat.

### **Taftan - Dalbandin**

The area is extremely dry and there is a severe lack of water in the region. Consequently, there are hardly any towns: Taftan, Nokundi and Dalbandin in a 300 km distance. Gravel plains are crossed by small dry wadis containing even drier vegetation. To the north are the Chagai Hills that mark the border with Afghanistan. The area is not suitable for locusts. The Taftan-Quetta road is in poor condition and travel is extremely slow (about 50 kmh).

### **Dalbandin - Nushki**

There is a large area of sand dunes from south-west to south-east of Dalbandin which has potential for locust breeding. Most of the dunes are south of the Taftan-Nushki road and continue to the Ras Koh mountain range; however, there are smaller areas to the north towards the Chagai Hills and Afghan border. This area is followed by sand and gravel plains with localised areas suitable for locusts, the largest being several cereal plots about 75 km west of Nushki in the Padag and Mal areas that extend for about 10 km. There is also a sandy area just east of Nushki. North of Mal is a vast salt flat.

### **Nushki - Quetta**

After Nushki, the road twists and turns, climbing over a set of mountains. The area is mostly barren rocky hills and increases in elevation with a few high valleys before joining the road from Karachi and climbing the final pass, dropping into the Quetta Valley which is surrounded by tall mountains that rise up to 9,000 feet.

### **Nushki - Kharan**

Barren rocky hills of the Ras Koh Range are first crossed south of Nushki followed by gravel plains and a few small sandy valleys along W. Baddo which is probably the main potential area for locusts. There are also a few smaller areas in K. Baddo beyond Patcin oasis towards Kharan. Rocky barren mountains are to the north (Ras Koh) and to the south-east (Unalath Range). The air becomes full of dust from the Baluchistan desert to the south and west as Kharan is approached. The village itself is on a flat treeless plain. Sand dunes start immediately on the southern and western edges of the village; those to the west extend for a long distance - the Baluchistan Desert - which probably is a good area for locusts but undersurveyed due to difficult access and a lack of tracks and villages. Those to the south follow W. Baddo and there are numerous plots of rainfed maize close to the small villages in the area. In Kharan Valley, the rainy period is from February to April.

### **Kharan - Panjgur**

South-east of Kharan, a large stony wadi, K. Baddo, is crossed to a small village, Sarawan, at the edge of the foothills of the Unalath Range. These hills are rocky and barren with small valleys until K. Gasi, a large wadi, is reached which continues to the small village of Basima. From here, rocky and gravel plains are crossed to a small oasis village of Padich. Just before Nag the plains open up into a wide area between hills to the north, the Siah Range, and to the south, the Rakhshan Range. The plains are oriented north-east to south-west and consists of only low bushes, no trees and are dry. The terrain is gravel with a few sandy spots. In the middle of the plain is K. Rakhshan. There are some small wheat plots and large square catchment basins in the wadi (with wheat) that continue beyond Nag to Panjgur. Palm trees are first seen in the Panjgur Valley. Panjgur itself is a long narrow oasis along the northern bank of the wadi.

### **Panjgur - Turbat**

South of Panjgur is a gravel plain and crossing this reaches the firth of a series of rocky hills that make up the Central Makran Range. These eventually turn into mountains which are at first separated by a sandy/gravel plain and a large wadi, K. Gwarkoh, then a very stony plain and more rugged mountains. There is no vegetation except for low wild palm bushes. As the mountains are crossed, the elevation steadily drops and temperatures rise. Before crossing the final set of mountains, a large salt flat is crossed with a few villages on its edges; otherwise, there are no villages in this area. Then wide open plains appear running in a north-east to south-west direction and the Coastal Makran Range can be seen across the plains to the south. These plains are extremely rocky and continue to Turbat. Along the length of this plain runs Kil Kaur and becomes quite wide at Turbat. Prior to this, Gish Kaur enters the Kil from the north and there are several oases. These and the wadi offer the only possible locust areas. Large square catchment basins with wheat are in or near the wadi. Many small and deep narrow rocky gorges feed into the main wadi from the mountains to the north and south. This is not a good locust area.

Turbat is a large oasis with the Kech Band mountains to the north. Most of the area is very dry since rains have far below normal this year. There was only one moderate fall during March and April which makes up two-thirds of the rainy period.

### **Turbat - Gwadar**

This is a rough long drive through the Dasht river valley and around the various mountain ranges to the coast. South of Turbat, the plains of gravel become sandy at Bandagli and this has potential as a locust area given rainfall. This area is followed by a large plain that continues to the foothills of the rocky Sajidi Band mountains. To the north are the Gokhprush Band mountains which can hardly be visible. Sandy areas adjacent to the foothills on the northern and north-western side towards the Dasht and along the Dasht itself are good locust areas. At the western end of the range is a large reservoir that extends onto the coastal plains for about 10 km. The end of the Sajidi consists of low gravel hills, one small range of similar height extends for several kilometres.. Similar hills are on the coastal side of the mountains and eventually flatten out near Gwadar. There are not suitable areas for locusts as they are gravel and rugged. However, there are sandy areas north-east of Gwadar in the Akara area and the Gwadar Peninsula (10 km by about 2 km) is sandy with low dunes. The table top mountains at both ends of the peninsula can be seen from the distance; the mainland mountain being more rugged than the seaside counterpart.

### **Gwadar - Pasni**

The coastal plains east of Gwadar are sandy/clay and much dissected by low hills and small shallow gorges and depressions. Some areas, mostly closer to the foothills are flatter and have rain-fed maize crops and there are a few tiny oases. The plains have only sparse vegetation and some Panicum sp. and other bushes. The coast range can be seen to the north, but the sea is nearly impossible to see. This area of the coast is of only limited potential for locust breeding due to its ruggedness. The plains become less rugged after Nalat closer to the foothills. Some valleys appear and some of these such as Kulanch and Kandasole can act as gregarizing sites (according to Popov). The valleys have sandy areas and small dunes and small maize plots. After Kandasole, the next valley to the east, Chugli, is larger and less suitable for locusts. This is followed by a wide open flat plains of hard clay and a few sandy spots. There are several good locust areas to the north and north-west closer to the foothills. In the distance towards the sea, the orange dunes of Pasni are visible. The locust outpost here does regular surveys of the area from 1 March to 30 May.

### **Pasni - Turbat**

K. Shudi, a large wadi, flows out of the coastal mountains onto the coastal plains north of Pasni. To the west is the end of the Sajidi Band mountains. Closer to the foothills of the Gokhprush Band mountains other tributaries flow into K. Shudi. There are numerous gravel plateaux in the mountains as well as low hills and canyons. In the middle of the range is the mountain oasis of Pidarek with its abundant water supply. Beyond is the highest peak of the range. The final range is crossed before dropping into Turbat Valley. This is not a suitable area for locusts because it is too rocky.

### **Turbat - Bela - Uthal**

The Turbat Valley extends north-east to Awaran and takes most of the day to travel from Turbat. It is rocky and rugged nearly the entire way and is really not suitable for locusts except for a few isolated spots close to the Kech wadi.

Awaran is mud brick village spread out in between several sandy wadis and there are a few potential sites for locusts close to the village in cropping areas. After Awaran, several extremely dusty and eroded sets of mountains are crossed with river valleys in between. The mountains themselves are barren with fine talk dust, the first set are sharp-edged hills and the last set are larger and steeper, and do not offer suitable sites for locusts; however, the valleys have grass and brush vegetation and are a bit more sandier that could be good for locusts. The first valley is Chil valley with thick grasses close to the wadi, then Nal valley with the Nal (or Hingol) wadi with vegetable gardens, orchards and crops, then the Kaur Arra valley which is gravel filled. The last valley is the Kaur Mukkabet after which the narrow mountain passes are crossed and you drop into the Las Bela valley and cross the wide Porali river before Bela.

The Las Bela Valley is a wide area of crops, some villages and sandy areas with mountains to the north, west and east and the sea to the south. The vegetation is dense in spots and very suitable for locusts. The valley becomes wider towards the south.

### **Uthal - Karachi**

South of Uthal towards Karachi there is large area of about 30 by 20 km with dense vegetation, sandy soil and sand dunes on the edges that is commonly infested with locusts. Sand dunes can be seen on the shores of Sonmiani Bay. Beyond this, small hills and sandy valleys are crossed north-east of Karachi.

## Appendix 5. Meteorological observations

Date	Hour	Name	Coordinates	Temp °C	RH %	Wind m/sec	Direction	Remarks
23.4.95	0745	Balaysar	2516N/6047E	29	78	1.3	e-w	
23.4.95	0900	15 km e Kashu	2513N/6059E	30	80	1.6	e-w	
23.4.95	0945	Bris area	2511N/6105E	32	80	3.2	s-n	
23.4.95	1050	Gwatar	2509N/6129E	33	80	4.0	s-n	
23.4.95	1150	Sirgara	n/a	38	56	2.7	s-n	
24.4.95	0945	Darak	2528N/5930E	31	40	3.8	e-w	
24.4.95	1025	Pushti	2529N/5927E	32	35	4.0	e-w	
24.4.95	1115	Kaiki	2530N/5926E	32	35	4.0	e-w	
25.4.95	1000	Sorgalm	2537N/5826E	29	80	1.6	s-n	
25.4.95	1130	Waink	2540N/5902E	30	60	1.6	w-e	
25.4.95	1225	Joosdar	2546N/5919E	34	56	3.0	sw-ne	
27.4.95	0845	Sardegal	2714N/6026E	25	63	0.8	sw-ne	
27.4.95	0915	Sardegal	2714N/6023E	26	63	1.1	sw-ne	
27.4.95	1010	Shams Abad	2712N/6020E	30	52	0.8	sw-ne	
27.4.95	1145	Korhaimemari	2707N/6041E	30	51	1.3	nw-se	
28.4.95	0900	Shandan	2722N/6154E	22	72	1.1	w-e	light rain
28.4.95	0930	N. Shandan	2723N/6153E	19	76	1.3	w-e	light rain
28.4.95	1035	Noorabad	2723N/6153E	17	81	3.8	w-e	light rain
28.4.95	1215	Hoshab Mohater	2708N/6148E	20	73	1.3	n-s	
2.5.95	0900	Padak	2859N/6512E	27	46	1.1	w-e	
3.5.95	1230	Ricoh	2911N/6555E	32	40	1.1	w-e	
3.5.95	1625	Gazi	2830N/6122E	38	36	1.3	nw-se	
3.5.95	1715	Jamak	2826N/6518E	38	33	2.7	nw-se	
3.5.95	1755	south of Jamak	2825N/6518E	37	34	0.5	nw-se	
3.5.95	1840	Bashor	2827N/6519E	36	34	0.5	nw-se	
4.5.95	0900	Dali	2814N/6541E	29	47	1.6	ne-sw	
4.5.95	1025	Chakar south	2800N/6546E	31	42	1.1	n-s	
4.5.95	1200	Padak area	2747N/6540E	32	40	4.0	nw-se	
4.5.95	1515	Jat	2720N/6450E	38	49	1.6	n-s	
6.5.95	0845	Bandga	2553N/6245E	35	66	1.6	e-w	
6.5.95	0940	Beerchat	2543N/6237E	34	70	3.0	e-w	
6.5.95	1120	Chaati	n/a	42	52	1.1	e-w	
6.5.95	1220	Shooli	2534N/6207E	42	58	1.6	w-e	
7.5.95	0850	Ziarat Machi	2515N/6224E	29	90	1.1	ne-sw	
7.5.95	0950	Jhori	2517N/6235E	31	88	1.1	ne-sw	
7.5.95	1035	Kapper	2519N/6242E	33	81	1.6	e-w	
9.5.95	0935	Wingoi	2538N/6636E	33	74	1.9	w-e	
9.5.95	1010	Tinkanda	2531N/6639E	34	70	2.1	w-e	

## Appendix 6. Proposed itinerary for 1996 joint border survey

*[note: survey days may vary in some areas depending on ecological conditions and unforeseen delays.]*

5-6 April	both teams travel to Mirjaveh/Taftan border crossing.
7 April	I.R. Iran team crosses into Pakistan; survey Taftan-Dalbandin; overnight Dalbandin.
8 April	survey west and north of Nushki; overnight Nushki.
9 April	survey Nushki-Kharan; overnight Kharan.
10 April	survey Baluchistan Desert; overnight Kharan.
11 April	survey Kharan-Panjgur; overnight Panjgur.
12 April	survey Panjgur area; overnight Panjgur.
13 April	survey Panjgur-Turbat; overnight Turbat.
14 April	survey Turbat area; overnight Turbat.
15 April	survey Turbat-Gwadar; overnight Gwadar.
16 April	survey west of Gwadar; overnight Gwadar.
17 April	survey Gwadar-Pasni; overnight Pasni.
18 April	survey Pasni area; overnight Pasni.
19-21 April	Pasni-Taftan transit
22 April	cross into I.R. Iran; survey Mirjaveh-Zahedan; overnight Zahedan.
23 April	survey Zahedan-Saravan; overnight Saravan
24 April	survey Saravan-Zaboli; overnight Saravan.
25 April	survey Saravan-Iranshahr; overnight Bampur.
26 April	survey Iranshahr Plains; overnight Bampur.
27 April	survey Iranshahr-Chabahar; overnight Chabahar.
28 April	survey Chabahar-Gwatar; overnight Chabahar.
29 April	survey Chabahar-Zaribad; overnight Zaribad.
30 April	survey Zaribad-Jask; overnight Jask.
1-3 May	Jask-Mirjaveh transit.
4 May	Pakistan team crosses into Pakistan at Mirjaveh.