



## Hunting pressure on two migratory species, Common Crane (*GRUS GRUS*) and Demoiselle crane (*Anthropoides Virgo*) in Khyber Pakhtunkhwa Province, Pakistan

Tariq Ahmad<sup>1</sup>, Faiz-ur-Rehman<sup>2</sup>, Gul Saba<sup>1</sup>, Nadeem Munawar<sup>1\*</sup>, Tariq Mahmood<sup>1</sup>, Faraz Akram<sup>3</sup> and Ammara Baig<sup>1</sup>

<sup>1</sup>Department of Wildlife Management, PMAS-Arid Agriculture University Rawalpindi, 46300, Pakistan

<sup>2</sup>Department of Zoology, University of Peshawar, KPK, Pakistan

<sup>3</sup>Department of Zoology, University of Kotli, Azad Jammu and Kashmir, Pakistan

### Key words:

<http://dx.doi.org/10.12692/ijb/19.4.76-83>

Article published on October 27, 2021

### Abstract

The present study was carried out at the three districts, i.e., Bannu, Lakki Marwat and Karak of Khyber Pakhtunkhwa Province, Pakistan. The current study was carried out to assess the biological status of two cranes species, the Common Crane (*Grus grus*) and the Demoiselle Crane (*Anthropoides virgo*), with respect to hunting pressure, chick survival rate and breeding and diseases in captivity. Field surveys, questionnaires and interviews with the local communities were the major tools for data collection. In the fall 2014 and spring of 2015, a total of 93 hunting camps was found to be established in Bannu and Lakki Marwat. These camps were established in Baran dam, Kurram and Kashu in Bannu, while Lunder, Chall and Gambilla River in Lakki Marwat. The study revealed that hunters in Bannu, Lakki Marwat and Karak had 2945 Demoiselle and 956 Common captive Cranes, from breeding pairs 1363 and 408 eggs of Demoiselle and Common cranes, from which 910 and 183 eggs were hatched and the chicks of these two species survived were 628 and 129 respectively. The chicks faced problems of development of feathers, leg-breaking and bending due to overweighting and parasitic attacks. The cranes also suffered from various diseases like a head tumor (granules develop on the head), night blindness, influenza, stomach blocking and skin diseases. The information of this study may help to develop strategies to conserve and protect the natural habitats from intensive anthropogenic use and livestock grazing and help to sustain and enhance numbers of this avian species.

\* Corresponding Author: Dr. Nadeem Munawar, PhD ✉ [nadeemmunawer@gmail.com](mailto:nadeemmunawer@gmail.com)

## Introduction

Cranes belong to the world's most threatened groups of the world. Of the fifteen cranes species, eleven are considered to be threatened by the international union for the conservation of nature (IUCN); of them, one species is critically endangered, while three species are endangered and seven species are vulnerable (International Crane Foundation; Crane Species, 2001). Threats that affect the cranes' population and their habitat include degradation and habitat loss, exploitation, climatic changes, pollution, poisoning, hunting, disturbance (Harwich, 2001). Deforestation has a long-term impact on watershed hydrology or wetlands, so Cranes that depend on forests can be directly affected by deforestation; cranes that require trees in their habitat are directly threatened by deforestation. Similarly, afforestation has an impact on the habitat of both grasslands and wetlands cranes. Increased tree plantation (usually conifers) reduces the availability of nesting and foraging areas subjects nearby wetlands to reduce run-off and desiccation. These threats can make the wetland-upland habitat unsuitable for cranes.

A large number of bird species use the Indus Flyway to winter at various destinations in Pakistan. Some crane species, members of family Gruidae, enter Pakistan through Koh-e-Sufaid, along the Kurram, Kashew, Gambilla and Indus rivers, in Bannu, Lakki Marwat and Dera Ismail Khan districts of Khyber Pakhtunkhwa province (Mian, 1981; Ahmad and Khursheed, 1991; Ahmad and Jan, 1995) and they settle in Kurram River valley, their first stopover in the country (Tehsin, 1988). Historically, four species of migratory cranes, i.e., Siberian Crane (*Grus leucogeranus*), Indian Sarus Crane (*Grus antigone antigone*), Eurasian Crane (*Grus grus*) and Demoiselle Crane (*Anthropoides virgo*), used to pass through Pakistan (Nawaz, 1984; Ali, 1993; Ali and Khan, 2007). Over the years populations of first two species have decreased drastically and are rated as "endangered" and "vulnerable", respectively, on the IUCN Red List of Threatened Species (IUCN, 2012). The last two species are more frequent during their autumn and spring migrations (Ahmad and Shah,

1987; Meine and Archibald, 1996; Nawaz *et al.*, 2006), but the population of the Eurasian Crane is declining due to hunting in Afghanistan and Pakistan (IUCN, 2010; WWF-P, 2011).

During migration, extensive hunting of cranes is performed in the southern districts of northern Pakistan. The districts of Bannu, Lakki marwat and adjacent tribal areas also fall on the migratory routes of cranes. People of these areas have been hunting migrating cranes in a specific, traditional way for centuries. Hunting of cranes in the spring season starts around the first week of March to April, while autumn hunting starts around early September to mid-October (Robert and Landfried, 1987). Peoples of these areas trapped live cranes for domestication and captive breeding by using decoying cranes to attract wild cranes by using their presence and calls (Khan, 2004). Local wildlife conservation authorities are making all possible efforts to prevent or reduce the hunting and maintenance or improvement of local habitats, with the aim to increase, or at least sustain, the visiting species and populations at the existing level. Such conservation efforts could be made more effective by generating scientific information on the health of the host ecologies and habitats for their potential to meet the basic needs (food and shelter) of their guests. The present study aimed to assess the biological status of two migratory cranes species, the Common Crane (*Grus grus*) and the Demoiselle Crane (*Anthropoides virgo*), with respect to hunting pressure, chick survival rate, number of infectious and parasitic diseases and breeding in captivity. The information would be useful for the local management agencies involved in the conservation of this crane species.

## Materials and methods

### Study area

The current research was conducted in Bannu, Lakki Marwat, and Karak, the southern districts of Khyber Pakhtunkhwa, Pakistan, during the fall of 2014 and spring 2015. The most important hunting areas of cranes, which include Bannu, Lakki Marwat, and adjacent district Karak. These districts comprise a

combination of hills and sandy plains characterized by sand dunes where the summers are very hot while the winters are moderately cool. The summer season begins in early April and continues till late October. June is the hottest month with minimum and maximum temperature ranges of 30–35°C and 42–45°C, respectively (Pakistan Meteorology Department, Islamabad). Bannu district forms a basin drained by the two rivers from the Hills of Waziristan, the Kurram River and the Gambila River; in Lakki Marwat, the Kurram river flows through the district from North West to the south-east and joins the Indus River south of Isa Khel town. One of its important tributaries is the Gambila River. Generally, the elevation of the hills ranges from 500 to 1000 m above sea level. The major natural flora observed and recorded from the study area consists of *Zizyphus mauritiana*, *Melia azederach*, *Acacia nilotica*, *Acacia modesta*, *Dalbergia sissoo*, and *Cedrela toona*, while the cultivated crops include *Allium sativum*, *Pennisetum glaucum*, *Zea mays*, *Sorghum bicolor*, *Triticum spp.*, *Brassica campestris*, *Spinacea oleracea*, *Cicer arietinum*, and *Trifolium alexandrium*. For data collection field survey was conducted and regular study visits were made to the study area. Field surveys, interviews, and questionnaires were the main tools for data collection.

#### Sample collection

The blood and fecal sample were collected from different areas of District Bannu, Lakki Marwat, and Karak from both Demoiselle and common captive cranes for the prevalence of blood and the intestinal parasite. Samples were taken from suspected cranes that were susceptible to various parasitic diseases. Fresh feces were collected in separate and clean 100

ml sterilized plastic bottles immediately after the cranes left, preserved with formalin, and stored at -20° C in the laboratory.

The direct smear technique was used for detecting the protozoan parasite as *Coccidia*. A few feces were mixed with the normal saline solution on a microscope slide. A coverslip was placed on top, and the slides were read under the microscope.

#### Statistical analysis

Descriptive statistics were performed to compute means and standard errors ( $\pm$ ) of the data. Two way of ANOVA technique were also used, when F-ratio was significant ( $P < 0.05$ ), post-hoc comparison between the means was carried out through Fisher's protected LSD test. All statistical calculations were performed using computer software namely "The Statistix v. 8.1" (Analytical Software, 2005).

## Results

### Hunting

#### Analysis of Hunting during fall 2014 and spring 2015 in District Bannu

During fall 2014, a total of 25 ( $8.33 \pm 4.5$ ) established hunting camps in different locations, i.e., 13 at Baran Dam, 4 at Kurram River, and 8 at Kashoo, were visited in Bannu. A total of 57 cranes, i.e., 46 ( $15.3 \pm 8.50$ ) Demoiselle and 11 ( $3.66 \pm 1.52$ ) Common cranes, were captured. During the study period, 9 cranes were killed, including 7 ( $2.33 \pm 0.57$ ) Demoiselle and 2 ( $0.66 \pm 1.15$ ) Common cranes.

The statistical analysis showed a significant difference ( $p < 0.05$ ) in crane hunting and it shows that hunting has a significant effect on the crane population and conservation in Bannu (Table 1).

**Table 1.** Numbers of Cranes captured and killed during spring 2014 and fall 2015 in Bannu Districts.

Hunting sites	No. of camps	Demoiselle Crane		Common Crane		No. of camps	Demoiselle Crane		Common Crane	
		captured	killed	captured	killed		captured	killed	captured	killed
Baran Dam	13 (52%)	25 (54.3%)	3 (42.8%)	5 (45.5)	2 (100%)	23 (56%)	42 (63%)	5 (62.5%)	11 (68.7%)	1 (100%)
Kashoo	4 (16%)	12 (26%)	2 (28.5%)	4 (36.3%)	0 (0%)	10 (24.3%)	14 (21.2%)	1 (12.5%)	3 (18.7%)	0 (0%)
Kurram river	8 (32%)	9 (19.5%)	2 (28.5%)	2 (28.5%)	0 (0%)	8 (19.5%)	10 (15%)	2 (25%)	2 (12.5%)	0 (0%)
Total	25	46	7	11	2	41	66	8	16	1
Mean $\pm$ SD	8.33 $\pm$ 4.5	15.33 $\pm$ 8.5	2.33 $\pm$ 0.57	3.66 $\pm$ 1.52	2.33 $\pm$ 0.57	13.6 $\pm$ 8.1	22.0 $\pm$ 17.4	2.6 $\pm$ 2.0	5.33 $\pm$ 4.9	0.33 $\pm$ 0.57

Similar to the fall season, a total of 41 ( $13.07 \pm 8.1$ ) hunting camps were visited during spring 2015 in Bannu (23 at Baran Dam, 10 at Kashoo, and 8 at Kurram River). A total of 82 cranes, including 66 ( $22.0 \pm 17.43$ ) Demoiselle and 16 ( $5.33 \pm 4.93$ ) Common Cranes were captured while 9 cranes have

killed, i.e., 8 ( $2.66 \pm 2.08$ ) Demoiselle, and only 1 ( $0.33 \pm 0.57$ ) common crane was killed. A statistically significant difference ( $p < 0.05$ ) was observed between crane hunting in Bannu and that hunting has a significant effect on crane population and conservation (Table 1).

**Table 2.** Numbers of Cranes captured and killed during spring 2014 and fall 2015 in Lakki Marwat District.

Hunting sites	No. of camps	Demoiselle Crane		Common Crane		No. of camps	Demoiselle Crane		Common Crane	
		captured	killed	captured	killed		captured	killed	captured	killed
Gambila river	4 (36.3%)	15 (47%)	2 (66.6%)	3 (43%)	1(100%)	7 (43.7%)	21(46.6%)	3 (43%)	3 (37.5%)	1 (50%)
Lunder	3 (27.2%)	9 (28%)	1 (33.3%)	2 (28.5%)	0 (0%)	5 (31.2%)	13 (28.8%)	3 (43%)	2 (25%)	0 (0%)
Chall	4 (36.3%)	8 (25%)	0 (0%)	2 (28.5%)	1 (0%)	4 (25%)	11 (24.4%)	1 (14%)	3 (37.5%)	1 (50%)
Total	11	32	3	7	2	16	35	7	8	2
Mean $\pm$ SD	$3.6 \pm 0.5$	$10.6 \pm 3.7$	$1.0 \pm 1.0$	$2.3 \pm 0.5$	$0.6 \pm 0.5$	$5.33 \pm 1.5$	$2.3 \pm 1.1$	$2.3 \pm 1.1$	$2.6 \pm 0.5$	$0.6 \pm 0.5$

#### *Numbers of Cranes captured during fall 2014 and spring 2015 in Bannu Districts*

A total of 11 ( $3.66 \pm 0.57$ ) established hunting camps were visited in Lakki Marwat (4 at Gambila River, 3 at Lunder, and 4 at Chall) during the study period of Fall 2014. A total of 39 cranes, i.e., 32 ( $10.66 \pm 3.78$ ) Demoiselle cranes and 7 ( $2.33 \pm 0.57$ ) common cranes were captured in selected hunting sites while 3 ( $1.0 \pm 1.0$ ) Demoiselle cranes and only 2 ( $0.6 \pm 0.5$ ) Common cranes were killed. The maximum number of cranes captured and killed was found in Gambila

River. Statistically, it was observed that a significant ( $p < 0.05$ ) difference in crane hunting and that significantly affected the crane's population in Lakki Marwat (Table 2).

Similarly, during spring 2015 in Lakki Marwat, a total of 16 hunting camps were visited (7 at Gambilla River, 5 at Lunder, and 4 at Chall). The statistical analysis showed a significant difference in crane hunting in Lakki Marwat and it shows the significant effect of hunting on crane conservation (Table 2).

**Table 3.** Data of Demoiselle Cranes Breeders in Bannu and Lakki Marwat and Karak collected between April-July 2015.

Regions	Breeders	Captive Cranes	Breeding Cranes N (%age)	Non Breeding Cranes N (%age)
Bannu	180	980	462 (47%)	518 (53%)
Lakki MARwat	240	1230	570 (46%)	660 (54%)
Karak	205	735	306 (42%)	529 (58%)
total	548	2945	1338	1607
Mean $\pm$ SD	$175 \pm 67.63$	$981.6 \pm 247.50$	$446 \pm 132.72$	$535.6 \pm 116.50$

#### *Breeding*

##### *Captive breeding status of Demoiselle crane*

During our current research, 548 ( $175 \pm 67.63$ ) Demoiselle cranes breeders were identified in District Bannu, Lakki Marwat, and Karak. A total of 2945 ( $981.6 \pm 247.50$ ) cranes were found with them in captivity. Among all 980 cranes that were observed with 180 breeders in District Bannu, 1230 cranes with

240 breeders were found in District Lakki Marwat and 105 Breeders with 735 cranes were found in District Karak. Of the total, 1338 ( $446 \pm 132.72$ ) cranes were active breeding cranes and the rest of 1607 ( $535.6 \pm 116.50$ ) cranes were non-breeding in both Districts. The highest percentage of non-breeding cranes was found in Lakki Marwat, while the lowest percentage of breeding cranes was also found

in Lakki Marwat. It was found statistically that no significant difference ( $p > 0.05$ ) was found in the captive breeding and non-breeding, behavior, and conservation of Demoiselle crane reared by the breeders in both districts. (Table 3).

A total of 1363 ( $449.33 \pm 138.58$ ) eggs were laid by the breeding cranes in the selected areas. Out of the total eggs laid 910 ( $303.33 \pm 95.17$ ) were hatched into chicks and the rest of 453 ( $151 \pm 44.19$ ) did not hatch.

Out of the total chicks, 628 ( $209.33 \pm 62.58$ ) survived and the remaining 215 ( $94 \pm 40.03$ ) died. The highest percentage of eggs laid and chicks hatched was found in Lakki Marwat and the highest percentage of chicks survived was found in Bannu. Statistically, it was observed that no significant difference was found ( $p = 0.068$ ) in eggs lying, chicks hatching, survival, and mortality rate of Demoiselle crane bred by the breeders in district Bannu and Lakki Marwat (Table 3).

**Table 4.** Data of chick's death collected during 2014-2015.

Crane Species	Chicks Died	Mortality Causing Factors n (%age)			
		Disease	Legs Breaking	Mud Trapping	By birth weakness
Demoiselle Crane	282	67 (24%)	140 (49.6%)	21 (7.4%)	54 (19%)
Common Crane	77	18 (23%)	37 (48%)	9 (12%)	13 (17%)
Total	359	85 (24%)	177 (49%)	30 (8%)	67 (19%)
Mean $\pm$ SD	$179.5 \pm 144.95$	$42.5 \pm 34.64$	$88.5 \pm 72.83$	$15 \pm 8.48$	$33.5 \pm 28.99$

#### *Captive breeding status of Eurasian Crane*

There were about 956 ( $318.6 \pm 82.43$ ) Eurasian cranes with 318 ( $106 \pm 25.15$ ) identified crane keepers in the selected area of Bannu and Lakki Marwat District. Out of the total 230 were found with 90 breeders in District Bannu, 393 were found in captivity with 135 breeders in District Lakki Marwat, and 333 were found in captivity with 90 breeders in district Karak. Out of 956 constituting approximately 337 ( $112.3 \pm 63.13$ ). Eurasian captive cranes were found as breeding, and the remaining 619 ( $206.3 \pm 75.2$ ) cranes were non-breeding (Table 3). The statistical analysis showed that no significant difference ( $p = 0.090$ ) was observed in the breeders of district Bannu and Lakki Marwat and Karak for the conservation of captive breeding and non-breeding cranes (Table 3).

#### *Mortality of Young Ones*

It was found by the breeders in the selected areas that the chicks of both Demoiselle and Common cranes died, as they faced the problems of parasitic attack, mud trapping, legs bending, and breaking due to becoming overweight during development. During the conducted survey, it was found that a total of 265

( $132.5 \pm 116.6$ ) chicks of Demoiselle and Common Cranes died collectively with selected breeders in both districts during 2014-2015 (Table 4).

#### *Common diseases of captive Demoiselle and common crane cranes and their local treatment*

Through interviews and discussion with crane hunters and breeders, it was found that the captive crane suffered from several diseases common to both Demoiselle and Common crane.

The most commonly found disease were a head tumor, night blindness, stomach blockage, influenza, leg-breaking, and certain skin diseases. For the treatment of such disease, the owners used to apply some traditional methods and certain medications.

The head tumor was treated to remove by incision. Adoxilin (A-D capsules), bread mixed with desi ghee and garlic, tetracycline (antibiotics), and white of domestic eggs were used for the treatment of night blindness, a stomach blockage, influenza, and leg-breaking, respectively, whereas myxil powder, coopex powder, and polyfax ointment were used for skin problems.

#### *Prevalence of Intestinal parasite in captive Demoiselle and Common cranes*

A total of 240 fresh fecal samples were collected from the study area. The samples were examined for helminths and protozoan parasites. Out of the total sample, 70 (29%) were positive for intestinal parasite and 170 (71%) were found to be negative (Table 4). Out of the total sample size, 71 samples were found to be positive for 2 coccidian protozoan, i.e., *Eimeria gruis*, *E. reichenowi*, and a single helminths species that was *Ascaridia galli*. The total prevalence of helminths and protozoan for Demoiselle crane was 40 (26.6%), while for Common crane was 31 (43.4%). Statistical analysis showed that no significant difference ( $P > 0.05$ ) was observed between the intestinal parasite in the Demoiselle and Common crane. It was observed that Coccidian was a common parasite that has a maximum prevalence for both cranes and was non-significantly prevalent in the general population of cranes in Khyber Pakhtunkhwa, Pakistan.

#### *Diet provided to cranes*

The cranes are omnivores, so they can rely on many types of foods; the diets provided to the cranes in selected areas have consisted of natural and variety of diets provided by the breeders in captivity. In Lakki Marwat, Bannu and Karak 310 breeders were visited. Same varieties of nutritive diets are provided by the breeders to both species of cranes in selected areas. The natural diet of both the cranes was grasshoppers, earthworms, snails, lizards, and pebbles. The pebbles were the favorite food of common captive cranes.

#### **Discussion**

The present research was carried out in Bannu and Lakki, southern districts of Khyber Pakhtunkhwa, Pakistan. Crane hunting is an old tradition in some regions of Pakistan. According to game staff and local villagers in the Chaghai district, about 20000 cranes enter each year through Zaro-Anam Bostan in Baluchistan in the fall and move eastwards. In the spring of 1989, about 700 cranes used this route. From this, it was concluded that the total number of cranes using Pakistan for migration could be around

50000 (Farooq *et al.*, 1993). It is estimated that there are currently 12,000 captive cranes in the Kurram valley, of KPK in Pakistan, of which hunters use around one-third as decoys in the trapping and hunting of cranes in each migration season (Khan, 2004). In 1966, 5000 cranes were reported to have either been trapped alive or shot. The hunters of the Kurram Valley trapped 4000 cranes and 100 were killed during the 1986 fall and the spring of 1987. About 3000 to 5000 cranes were captured in 1995 (Ahmad and Jan, 1995). During the 2008 fall and 2009 spring, a total of 2080 cranes were captured and 559 were killed. Of the 2080 captured cranes, 1580 were Demoiselle Cranes and 500 were Common Cranes, while 509 Demoiselle and 50 Common Cranes were killed (Perveen and Khan, 2010).

Captive breeding represents the most intimate involvement of people with cranes and has a long history. Cranes have been kept in captivity for at least 2500 in China (WWF-P. 2011). In the late 1960s, captive breeding was attempted as a tool for conservation (Ericson, 1976). With the aim to assure that substantial numbers of chicks could be raised for most endangered species (Mirande, 1991). Worldwide, populations of many wild cranes have declined and have vanished entirely from some countries. In order to safeguard the populations against extinction, captive breeding programs have been initiated by various national and international organizations, such as the International Crane Foundation (ICF) and the Crane Breeding and Conservation Centre (CBCC) (Primack, 1998). In 1966, the Canadian Wildlife and the US Fish and Wildlife Service began a whooping crane captive breeding programme for the conservation of this rare species of the world. The KPK Wildlife Department permits the keeping of cranes in captivity and issues a possession license for these cranes. However, those that are bred in captivity are excluded from regulations and can be kept without a license. An estimated population of 4,000 Eurasian and 8,000 demoiselle cranes are in captivity in Bannu, Lakki Marwat, and adjacent tribal areas. The majority of them have come through capturing from the wild,

while a tremendous proportion of it includes many homebred pairs (Khan, 2004).

According to Perveen and Khan (2010), with 1,650 hunters in Bannu and Lakki Marwat, 920 hunters had breeding pairs of captive cranes. A total of 950 hunters in Bannu had 710 breeding pairs of captive cranes, while in Lakki, 700 hunters had 210 breeding pairs; it was found that 1,650 hunters had 920 breeding pairs of cranes. From those pairs, 98% productivity, 900 eggs fecundity, 71% fertility, and 61% hatchability were obtained (Ahmad and Jan, 1995). Halibey (1976) documented that in captive breeding, crane pairs that consumed a variety of foods had highest reproductive success than those receiving either single (carbohydrates) or two types of food (carbohydrates and proteins).

It was concluded from the results that the total breeding pair of Demoiselle crane in the study area were 669, while of the Common crane were 337. The chicks' survival rate of Demoiselle crane was 69%, whereas the Common crane was 70%. Hunters in Bannu and Lakki Marwat have succeeded in breeding cranes in captivity. Successful captive breeding on a large scale can reduce hunting pressure on wild cranes considerably. It will also safeguard the elimination of the cranes through hunting. The disease may pose a significant threat to the crane's populations. Cranes suffered a number of diseases while inhabiting variable habitats, including head tumors, influenza, a stomach blockage, malaria and parasitic attack.

The findings of this study suggest that the natural habitat which falls in the range of potential crane stopover areas should be protected from intensive anthropogenic use and livestock grazing to provide the chance of propagation for wild flora and associated fauna. The population of migratory cranes is expected to decline in southern districts of Northern Pakistan due to overhunting, destruction of habitats and a high level of anthropogenic activities. Local and International agencies involved in cranes conservation shall develop programmes to create

public awareness and stop hunting during the period of migration/stopover. In order to protect and restore the endangered crane population and its habitat, the following specific suggestions for protection at the local level must be taken: 1) the rules regarding the hunting of cranes need to be revised and oriented more towards protection; 2) improve the technique of breeding populations; 3) study the factors behind poor reproduction and rates of recruitment in crane population with an effective reintroduction of cranes; 4) expand cooperation and collaboration among ornithologists, conservationists and those working in the breeding range of cranes populations; 5) take eco-tourism measures and extend public education programs involving farmers and 6) habitats should be protected from agro-industrial chemical pollution.

#### References

- Ahmad A, Khursheed N.** 1991. Observations of migration and migratory routes of cranes through Balochistan in autumn 1991. *Natura* **13**, 8-11.
- Ahmad A, Jan A.** 1995. Cranes in Pakistan. In: Prange, H. (ed.) Crane research and protection in Europe. Proc. 1989 Palearctic Crane Workshop; Tallinn, Estonia, p 337-352.
- Ahmad A, Shah SIH.** 1987. The future of cranes in Pakistan with special reference to NWFP. In: Harris, J.T. (ed.) *Proc. 1987 International Crane Workshop*, Quiqihar, Heilongjiang, China, p 335-339.
- Ali SK.** 1993. Reappearance of the sarus crane in Pakistan. *Wildlife Environment* 8-9.
- Ali Z, Khan A.** 2007. Captive breeding and multiple clutching techniques of captive cranes in Bannu and Lakki Marwat, NWFP. A research report submitted to the Ministry of Environment's Pakistan Wetlands Programme, p 42.
- Ericson RC.** 1976. Whooping Crane studies at the patuxent Wild Life Research centre.166-176 in Lewis J.C, editor. *Proceeding international Crane Workshop*. Oklahoma State University, Stilwater,

USA.

**Farooq M, Ahmad A, Ghalib SA.** 1993. The cranes of Pakistan. World wide fund for nature, Pakistan, 1-54.

**Halibey T.** 1976. Feed and feeding habits of captive cranes. International Crane Foundation report. 1-19.

**Harwich RH.** 2001. Developing a migratory Whooping Crane Flock. National American Workshop **8**, 85-95.

**International Crane Foundation, Crane Species: Red Crowned Crane Web site.** 2001. <http://www.savingcranes.org/species/red-crwn.asp>.

**IUCN.** 2010. Cranes. IUCN Red List of Threatened Species. Version 2010.4. [www.iucnredlist.org](http://www.iucnredlist.org)

**IUCN.** 2012. IUCN Red List of Threatened Species. Version 2012.2. Accessed on 28 February 2013. [www.iucnredlist.org](http://www.iucnredlist.org)

**Khan A.** 2004. Habitat status and hunting pressure on migratory cranes in Pakistan and assessment of Abi-i-Estada in Afghanistan with proposed conservation plans for selected wetlands. MSc dissertation, University of Wisconsin, Madison, p 70.

**Meine CD, Archibald GW.** 1996. The Cranes: status survey and conservation action plan: IUCN, Gland, Switzerland and Cambridge, p 294.

**Mian A.** 1981. Crane migration through Balochistan.

A preliminary report. Journal of the Bombay Natural History Society **86**, 98-100.

**Mirande C.** 1991. The role of Captive breeding in conservation of crane. 425-432 in Harris J, Editor. Proceedings 1987 International crane workshop. International crane foundation, Baraboo, Wisconsin USA.

**Nawaz M.** 1984. Migratory cranes in Pakistan. Tigerpaper **11**, 17-20

**Nawaz M, Nawaz Y, Malik FM, Shahabuddin.** 2006. Hunting pressure and impact of Afghan refugees on migratory cranes in Pakistan. Zoo's Print Journal **21**, 2333-2334.

**Perveen F, Khan HU.** 2010. Pressure from hunting on Crane Species in Southern Districts of Northern Pakistan. China Birds **1**, 244-250.

**Primack RB.** 1998. Essentials of Conservation Biology (2<sup>nd</sup> Ed.). Sunderland and Massachusetts Publications, USA, p 659.

**Robert TJ, Landfried SE.** 1987. Hunting pressure on cranes migrating through Pakistan. In: Archibald GW, Pasquier RF (Eds) Proceeding of the International Crane Foundation, Baraboo. University of Wisconsin, Madison, USA, 139-250.

**Tehsin R.** 1988. Migrating Demoiselle Cranes. Tigerpaper **14**, 26-27.

**WWF-P.** 2011. [http://www.wwfpak.org/sp\\_cranes.php](http://www.wwfpak.org/sp_cranes.php)