

**POPULATION STATUS AND HABITAT SUITABILITY OF SARUS  
CRANE (*Antigone antigone*, Linnaeus, 1758) IN BANKE DISTRICT,  
NEPAL**



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**A thesis submitted in partial fulfillment of the requirements for the award of the degree  
of  
Master of Science in Zoology with special paper Ecology and Environment.**

**Submitted to  
Central Department of Zoology  
Institute of Science and Technology  
Tribhuvan University  
Kirtipur, Kathmandu  
Nepal**

**December, 2016**

## **DECLARATION**

I hereby declare that the work presented in this thesis has been done by myself, and has not been submitted elsewhere for the award of any degree. All sources of information have been specifically acknowledged by references to the author(s) or institution(s).

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Kirtipur, Kathmandu, Nepal

**RECOMMENDATION**

This is to recommend that the thesis entitled “**POPULATION STATUS AND HABITAT SUITABILITY OF SARUS CRANE (*Antigone antigone*, Linnaeus 1758) IN BANKE DISTRICT, NEPAL**” has been carried out by **Ms. Shraddha Tiwari** for the partial fulfillment of **Master’s Degree of Science in Zoology** with special paper Ecology and Environment. This is her original work and has been carried out under my supervision. To the best of our knowledge, this thesis work has not been submitted for any other degree in any institutions.

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**LETTER OF APPROVAL**

On the recommendation of supervisor “Prof. Dr. Nanda Bahadur Singh” this thesis submitted by **Ms. Shraddha Tiwari** entitled “**POPULATION STATUS AND HABITAT SUITABILITY OF SARUS CRANE (*Antigone antigone*, Linnaeus 1758) IN BANKE DISTRICT, NEPAL**” is approved for the examination and submitted to the Tribhuvan University in partial fulfillment of the requirements for **Master’s Degree of Science in Zoology** with special paper Ecology and Environment.

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**CERTIFICATE OF ACCEPTANCE**

This thesis work submitted by **Ms. Shraddha Tiwari** entitled " **POPULATION STATUS AND HABITAT SUITABILITY OF SARUS CRANE (*Antigone antigone*, Linnaeus 1758) IN BANKE DISTRICT, NEPAL**" has been accepted as a partial fulfillment for the requirements of Master's Degree of Science in Zoology with special paper Ecology and Environment.

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## ABSTRACT

The Sarus Crane (*Antigone antigone*) is listed as “vulnerable” in the Red List of Threatened Species by International Union for Conservation of Nature (IUCN). Sarus Cranes are distributed in the lowlands from Chitwan to Kanchanpur Districts of Nepal. Most of them are recorded from the outside of protected areas, especially in farmlands and wetlands of Terai region. The continued expansion of agricultural land and the loss of natural wetlands habitats are the most serious threats to the species. Present study was carried out to assess the population status and habitat suitability of Sarus Crane in Banke District. The study was conducted from 1 November 2015 to 30th January 2016. Direct observation through trial transects survey methods were used to estimate the population status of Sarus crane. Geographic parameters of sighting points were recorded for determining habitat suitability. The conservation threats were analyzed by field, questionnaire surveys. The study areas contained 51 Sarus Cranes out of which 48 were adult and eight were chick. The Sarus Cranes were found to use all habitats viz. farmlands, wetlands, grasslands. Farmlands and wetlands areas contained the highest number of Sarus Crane but preferred more farmlands for foraging followed by wetlands and grasslands. The frequency of the Sarus Cranes was highest in farmlands (62.74%), followed by wetlands (31.37%), and grasslands (5.88%).

The Sarus Cranes facing threats such as drying of wetlands, expansion of agricultural land, conversion of wetlands, over exploitation of wetlands, poaching, along with developmental activity, chemical fertilizer and disturbance in foraging and nesting place. Increasing awareness about conservation to local people, encourage the use of biological control methods and organic farming instead of chemical fertilizer and insecticides pesticides, protection and restoration of wetland, further research, establishment of Crane conservation area and continuous population monitoring are some of the ways to save the Crane in Banke District.



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## LIST OF ABBREVIATIONS

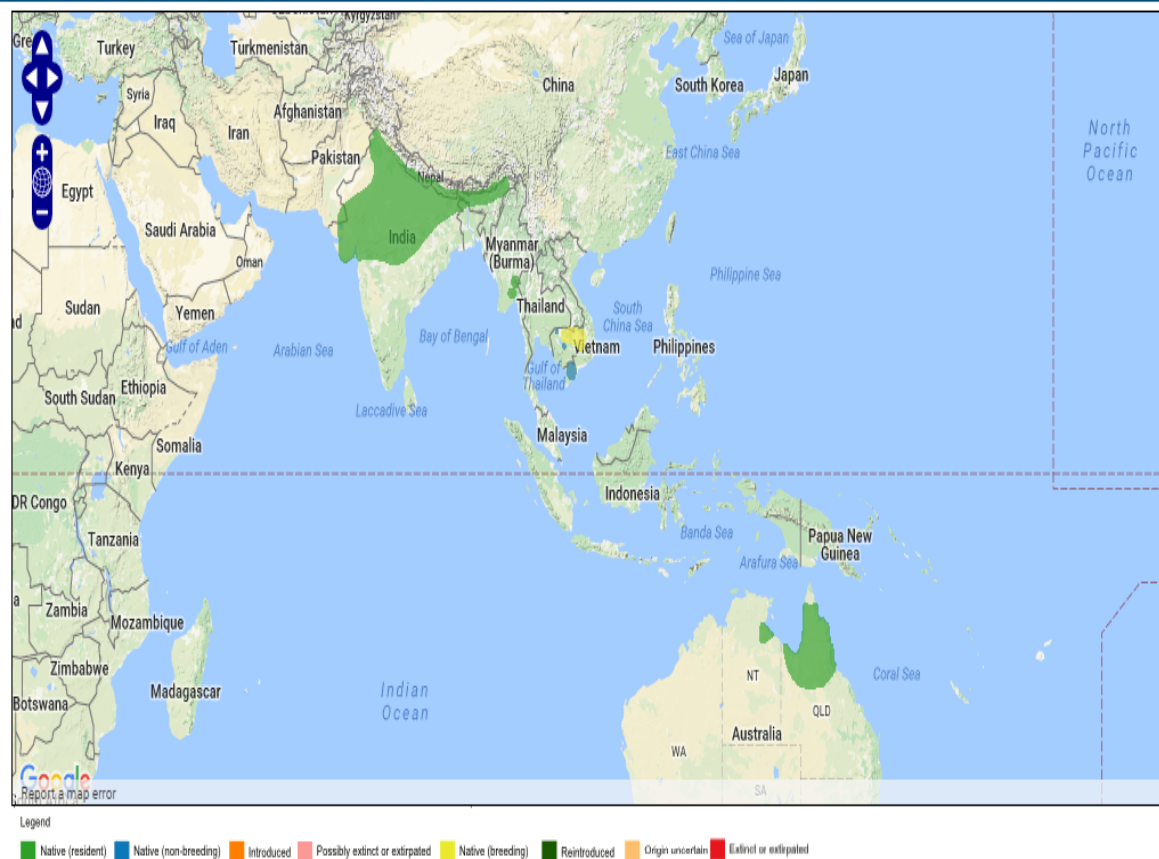
<b>Abbreviated form</b>	<b>Details of abbreviations</b>
BCN	Bird Conservation Nepal
CBS	Central Bureau of Statistic
VDCs	Village Development committee
DDC	District Development Committee
DHM	Department of Hydrological and Metrology
DWNPC	Department of National Parks and Wildlife Conservation
IUCN	International union for Conservation of Nature

# 1. INTRODUCTION

## 1.1 BACKGROUND

The name “Sarus” has its origin from Sanskrit word- ‘sarasa’ which means “lake bird” and it is so named due to its particular dance. The skin of this bird was first studied and described by Carolus Linnaeus who named it as *antigone* in 1758. The term “*antigone*” refers to a female character in Greek philosophy, famous as a rebellious daughter of the king Oedipus. There are fifteen species of the cranes existing in the world belonging to four genera and two sub-families. Out of fifteen species of Crane found worldwide, four are recorded from Nepal (DNPWC and BCN, 2016). Among them, three are migratory: Common Crane (*Grus grus*) and Demoiselle Crane (*Anthropoides virgo*), are the high altitude passage migrants from the Palaearctic region and Black-necked Crane (*Grus nigricollis*) a vagrant species. They are Tibetan highland species, and a small population migrates to Bhutan (Baral, 2009 and Grimmett *et al.*, 2000).

The Sarus Crane (*Grus antigone*) is a non-migrant sub-species of Indian sub-continent (Inskipp and Inskipp, 1991). Sarus Crane the world’s tallest flying bird (Archibald *et al.*, 2003), is the only resident breeding Crane in India and Southeast Asia (Chaudhary *et al.*, 1999). The Sarus Crane is monogamous bird and also known as the eternal symbol of unconditional love and devotion and good fortune. Sarus Crane is known for its marital fidelity, believed to mate for life and pine the loss of their mates even to the point of starving to death (Yaseen *et al.*, 2013). The Sarus Crane has been listed as “Vulnerable” in the IUCN Red List of Threatened Species. Approximately 8,000-10,000 individuals of the *antigone* subspecies inhabit Nepal, India, and Pakistan (Birdlife International, 2012). However, the population is declining (Archibald *et al.*, 2003). They are social birds (Lloyd and Mitchinson, 2009) and large flocks exist, especially during the breeding season (Johnsgard, 1998).



Source: BirdLife International (2016) IUCN Red List for birds.

**Figure 1: Global distribution map of Sarus Crane**

The current range of the Sarus Crane includes the plains of northern, northwestern, and western India and the western half of Nepal's Terai lowlands. The population has declined sharply over the last several decades. Sarus Cranes are most common and densely distributed in the Indian states of Uttar Pradesh, Rajasthan, Gujarat, and Haryana; they are less common in Bihar and Madhya Pradesh (Gole, 1989). In India percentage of breeding Sarus Cranes is maximum in Gujarat state though the maximum number of Sarus Cranes breeding is in Uttar Pradesh (Choudhury *et al.*, 1999). There are probably fewer than 500 in all of Nepal and their range has been slowly shrinking for the last decade (Suwal, 2003). In Pakistan, India's Punjab, and western Bangladesh, the Sarus Crane now occurs rarely (Meine *et al.*, 1996).

In the past, Sarus Crane was distributed in the entire lowlands from east to west; however, at present, its distribution is only recorded from Chitwan to Kanchanpur District of the western lower lands of Nepal (Baral, 2009; Inskipp *et al.*, 2016).

The adult Sarus Crane is very large with grey wings and body; exposed red head; a grayish crown; and a long greenish-grey beak. A Crane can appraise about 2-meter in height (over 6 ft.), with wingspan up to 2.5-meter wide (about 8 ft) having weight of 7 to 10 kg (Ali and Ripley, 1980; Singh and Tatu, 2000).

Sarus Cranes are omnivorous, eating insects (especially grasshoppers), aquatic plants, fish perhaps only in captivity, frogs, crustaceans and seeds (Singh and Tatu, 2000; Johnsgard, 1983; Meine and Archibald, 1996b; Verma and Prakash, 2016). Sarus Crane is the symbol of a healthy wetland ecosystem. Sarus Crane is an omnivorous bird and maintains the food chain and food web furnish strength to wetlands ecosystem. Most of their nutritional requirements are available in natural wetlands, but due to increase in agricultural activity, Cranes are increasingly forced to use crops field for foraging (Ali and Ripley, 1995; Aryal *et al.*, 2009; Gosai *et al.*, 2016). Occasionally Sarus Crane feed eggs of other birds (Sunder, 2000).

Sarus Cranes generally assemble during pre-monsoon and winter season (Singh and Tatu, 2000; Sunder and Chaudhary, 2008). Sarus Crane have an elevated and tapering bill that is often larger than the head, and nostrils are oval or nearly linear and are open from side to side, the upper half of the head is nearly naked and crimson skin is exposed, toes are not webbed, but are connected at the base by a membrane and are moderately long (Suwal, 1999). The profile of extended wings is round and has ten functional primaries (a vestigial 11<sup>th</sup>, in most case) with a seventh or eighth primaries are the longest (Johnsgard, 1983). The molting wings feathers make the Crane flightless once in a year or once in two years (Gole, 1989). The tail is moderately long and is composed of 12 features, no sexual dimorphism and all species are monogamous but usually gregarious during non-breeding season (Ali and Ripley, 1980). Plumage entirely pale grey, with the exception of the lower neck and tips of the wings which are whitish, head and upper neck bare the fore crown being greenish grey and very small ear coverts pale grey, otherwise the whole of the bare are in pale red with blackish hairs on nape and sides of neck, iris orange, bill greenish horn, leg and feet reddish (Johnsgard, 1983).

Sarus Crane occasionally seen in the damp cultivated field and usually lives in pair and sometimes seen in a flock of 40-60 during pre-nesting season (April-may) (Suwal, 1999). They are more social during gathering; there would be display and trumpeting (Ali and Ripley, 1980).

The Sarus Cranes utilize wide variety of landscapes, depending on food availability, cropping pattern and other seasonal factors (Mukherjee *et al.*, 2001). The Sarus Crane inhabit in open, cultivated, well water plains, marshlands and jheels (Ali and Ripley, 1980) and are well known for their ability to live in association with human habitation (Gole, 1989; Meine and Archibald, 1996). Habitat selection by birds is strongly influenced by security and food availability (Tortosa and Villafuerte, 2000; Aryal *et al.*, 2009), which can significantly affect reproductive performance (Zanette *et al.*, 2000). Insufficient food can reduce the rate, and delay the initiation, of reproduction and can influence species mortality (Lack, 1954). However, the major food items consumed by Sarus Cranes, and their availability at sites where the species congregates during the non-breeding season, are largely unknown in Cambodia.

The Sarus Crane reaches the sexually maturity at the age of five to seven years; the nesting is stimulated by the onset of wet season with associated flooding and



environmental changes that favor nesting at this period (Johnsgard, 1983). The nesting season is mainly from July to October but may extend into December or even March (Soothill and Soothill, 1982). The pairs produce a resonating trumpet call as duct (Mukherjee *et al.*, 2001). The trumpet is uttered with neck fully stretched up by both birds, bills pointing to the sky, the wings of the male half stretched, body feathers shuffled, kept up for half a minute or more (Sunder, 2005). The male and female of a pair are known to strengthen the pair bond by synchronized behavior such as duct calls, dance guard calls and alarm calls (Masatomi, 1994; Archibald, 1976). The pair shares most of the activity and generally lives together, except during the incubation, one of the mates has to leave the nest for short duration for foraging (Suwal, 1994).

Once widespread across Southeast Asia, Sarus Crane regional populations have declined sharply due to the loss and degradation of wetlands, hunting and egg collection. The species has been extirpated from Malaysia, the Philippines and Thailand (Johnsgard, 1983; Meine and Archibald, 1996; Birdlife International, 2012; Insee *et al.*, 2014), but recently reintroduced to Thailand (Tanee *et al.*, 2009; Insee *et al.*, 2014). Annual counts of the population in Cambodia and southern Vietnam normally range between 650–878 birds, but numbers counted have decreased in recent years (Van Zalinge and Triet, 2014). Various anthropogenic activities, habitats degradation and alterations are the main cause of declining of Sarus Crane population (Jha and McKinley, 2014).

Sarus cranes have evolved to inhabit wetland areas and will predominantly nest in marshlands (Ali and Ripley, 1983; Gole, 1989; Latt, 2001; Walkinshaw, 1973). Nests are typically composed of aquatic vegetation and submerged in water. Nests are circular or oblong with a broad base and a depression in the center (Mukharjee *et al.*, 2000). At dawn and dusk only, Sarus Cranes fly short distances at the tree canopy level between foraging areas and roosting sites (Ali and Ripley, 1969). With regard to potential threats to Sarus Cranes in Nepal, few studies have described the impact of human activities on the Sarus Crane habitat (Aryal *et al.*, 2009; Inskipp and Baral, 2010). Studies have recommended enhancing conservation awareness within local communities around important Sarus Crane breeding sites (Aryal *et al.*, 2009; Sundar and Choudhary, 2003), increasing the number of smaller wetlands (Archibald *et al.*, 2003), encouraging farmers to protect nests (Khacher, 2006), and establishing baseline data on Sarus Crane ecology (Sundar *et al.*, 2000).

The species is declining in this area because of the deterioration of wetlands (Suwal and Shrestha, 1992). Studies suggest that the farmlands of the Rupandehi and Kapilvastu districts are the main areas where Sarus Cranes breed regularly (Aryal, 2004). Jagadishpur Reservoir (also within the Terai region) and its surrounding areas are prime habitats for maintaining viable populations of Sarus Crane and other water birds (Aryal *et al.*, 2009). The non-breeding population generally exists in flocks using larger wetlands for roosting, whereas breeding pairs exist in discrete territories with an adequate water supply (Sundar, 2009).

## **1.2 OBJECTIVES**

### **1.2.1 GENERAL OBJECTIVE**

1. To ascertain the population status and habitat suitability of Sarus Crane in Banke, Nepal.

### **1.2.2 SPECIFIC OBJECTIVES**

1. To assess the population status of Sarus Crane within study area.
2. To collect information on the habitat and habitat utilization by Sarus Crane.
3. To identify conservation threats to Sarus Crane in human interface in study area.

## **1.3 STATEMENT OF THE PROBLEMS**

Among fifteen species of Crane, the Sarus Crane is found in Nepal. The Sarus Crane is still common in northern India, rare in south east part of Terai region of Nepal but has extirpated from large portions of its historic range and continues to decline in area where it still exists (Suwal, 1999). Small and isolated population of Sarus Crane occurs in the part of south-east lowlands (near India) Terai of Nepal. With action drastically reduction in its distribution in its distribution range and a total of 12000 individuals worldwide (Gole, 1989, 1990a). The Sarus Crane is now consider as a globally threatened species (BCN and DNPWC, 2011; Birdlife International, 2016; Inskipp *et al.*, 2016; Harris and Mirande, 2013). The range as well as population of Sarus Crane is in declining trend in Nepal because expansion of agricultural land, over exploitation of wetlands, and excessive use of agrochemical (Shrestha, 1996; Aryal *et al.*, 2009). But this information is not sufficient to manage the population in the country.

## **1.4 RATIONALE OF THE STUDY**

Most of the studies are concerned in Lumbini area. But this study has generated latest information on the population status and habitat suitability of Sarus Crane in Banke District, Nepal, where the flock of these birds has been recently discovered by the Nepalese Ornithologist. It is hoped that these informations will be useful to prepare guideline for conservation of Sarus Crane in the District.

## **1.5 LIMITATIONS OF THE STUDY**

The present research work has been conducted for the partial fulfillment of the Master's Degree in Zoology at T.U., Kathmandu, Nepal. So the time has been one of the most limiting factors for this study.

Due to the limited time the study period was taken at post breeding season so it was difficult to collect the data of nest of the Sarus Crane.

## 2. LITERATURE REVIEW

Histologically, Sarus Crane occurred throughout the northern parts subcontinent, south of Himalayas from Pakistan eastward to India, Nepal and first sighting of the Sarus Crane in western Nepal (Rand and Fleming, 1957). Approximately 8,000-10,000 individuals of *antigone* subspecies inhabit Nepal, India and Pakistan (Birdlife International, 2012). In the past, Sarus Crane was distributed in the entire lowlands from east to west; however, at present, its distribution is recorded from Chitwan to Kanchanpur District of the western lower lands of Nepal (Baral, 2009 and Inskipp *et al.*, 2016).

It has been noted in several publications that the number of Indian Sarus Crane has declined, and its geographical distribution has shrunk over time (Gole, 1989, Meine and Archibald, 1996). The number of Sarus Crane in Gujarat is estimated to have 1,730 (Singh and Tatu, 2000), Rajasthan with 332 (Vyas, 2002) and other states 183 (Sundar *et al.*, 2000a). An additional 168 were reported in trans-Indian Nepal Terai (Aryal *et al.*, 2009).

Shrestha (1996) studied population status of Sarus Crane in Nepal and found 128 number of Sarus Crane during 1995 and 131 number of Sarus Crane during 1996 in Nepal. Vyas (2001) studied status of Sarus Crane in Rajasthan and its ecological requirements and found the total number of Sarus Crane was 332 of which 139 pairs were with a sub-adult, juvenile or chick and 54 birds were young and also found 70% of the bird were seen in inundated fields, marshes or near water body and 27% were in fallow, harvested fields.

Sharma (2006) studied status, distribution and habitat preference of Sarus crane in Western part of Nawalparashi district and found the total number of Crane was 280, 257 and 202 in pre-nesting, nesting and post-nesting period; respectively and also found that the preferred habitat was wetlands for foraging and nesting followed by grasslands and cultivated lands.

Aryal (2009) studies conservation regime and local population ecology of Sarus Crane in west-central region of Nepal and found total 168 population of Sarus Crane, out of them 100 numbers of Sarus Crane found in Rupandehi district and 68 number of Sarus Crane found in Kapilvastu district.

Poudel (2012) studied status, habitat preference and conservation threats of Sarus Crane around Jagadisapur Reservoir, Kapilvastu, Nepal and found the frequency distribution of Sarus crane was 82, 68, and 52 in winter, summer and rainy season; respectively and also found that the preferred habitat was wetland for foraging followed by cultivated lands and grasslands.

Yassen, Sexena and Dubey (2013) studied population composition, distribution and habitat preference of Indian Sarus Crane in Chittaurgarh District, southern Rajasthan and found the total number of Sarus Crane was 280 counted in 2010, 322 in 2011 and 329 in 2012 during survey and found wetlands were most commonly frequented by Sarus Crane.

Jha and Mckinley (2014) studied demography and ecology of Indian Sarus Crane in Uttar Pradesh, Northern India and found total population of Indian Sarus Crane was observed to be 11,905 and also found the preferred habitat was central plain and south western semi-arid plain for foraging and nesting followed by Terai Agro-climatic zone, and no Crane were observed in Vindhyan zone.

Yaseen *et al.* (2014) studied population status of Indian Sarus Crane in south Rajasthan India and found the total population 458 adults and 90 juveniles were counted during the winter survey while 687 adult and 111 juveniles during summer and also found 83.21% and 80.83% of Sarus Crane in marshes and close to wetlands whereas 16.79% and 19.17% were found in harvested and crop fields in the two surveys; respectively.

Tripathi (2014) studied status and ecology of Sarus Crane in Sitapur district, Uttar Pradesh and found the total population of Sarus Crane was 250 and also found that the preferred habitat was mix of natural wetlands in the landscape.

Ansari (2015) studied population composition and distribution of Indian Sarus Crane in Gautam Budh Nagar district, with special reference to Surajpur wetland, National Capital Region, India and found 6 individuals in 2010, 4 in 2012, 14 in 2013 and 22 in 2014 and recorded maximum number of Sarus Crane in summer season and minimum number in monsoon season.

Gosai *et al.* (2016) studied population structure, behavior and current threats to the Sarus Crane in Nepal and found 143 Sarus Cranes in Rupandehi District and recorded that agricultural land and wetland areas contained the highest number of Sarus Cranes.

Verma and Prakash (2016) studied Demographic studies of Indian Sarus Crane in and around Alwara Lake of District Kaushambi (U.P.), India and found the total population of Sarus Crane was 335 in 2012 and 425 in 2013 around Alwara lake.

Katuwal (2016) studied Sarus Crane in lowlands of Nepal: Is it declining really? And found overall population of Sarus Crane has increased in Nepal.

In recent times, the population of Sarus Crane is in threats due to the destruction of its habitat, pollution, and agricultural development (Aryal *et al.*, 2009; BCN and DNPWC, 2011). Gosai (2016) reported that the major threats to the survival of Sarus Crane are habitat destruction, people hunting for meat, egg stealing, electrocution, cattle grazing, and the agricultural use of pesticides.

### 3. MATERIALS AND METHODS

#### 3.1 STUDY AREA

Banke district lies in Terai region and situated in Bheri Zone of Mid-Western development region of Nepal. The district is located in the latitude of 27° 50' to 28° 20' N and the longitude of 81° 30' to 82° 10' E. The elevation of Banke is 174.63 and covers an area of 2337 square Km. Banke district expands in an area of 2337 square Km between Bardiya, Salyan, and Dang districts of Nepal and Baharaich district of India (District profile, 2016). Geographically, most (79.1%) of the district is plain area or Terai (< 300msl) while 20.6 per cent of land is within 300 to 1000 msl. Only 0.3% of land in Chure hills in the North reaches an altitude up to 1236 msl (Barnekow *et al.*, 2005). Banke district is a rural district with 85 per cent of its 0.49 million population (CBS, 2011) living in the forty-six VDCs and only 15 per cent in Nepaljung municipality.

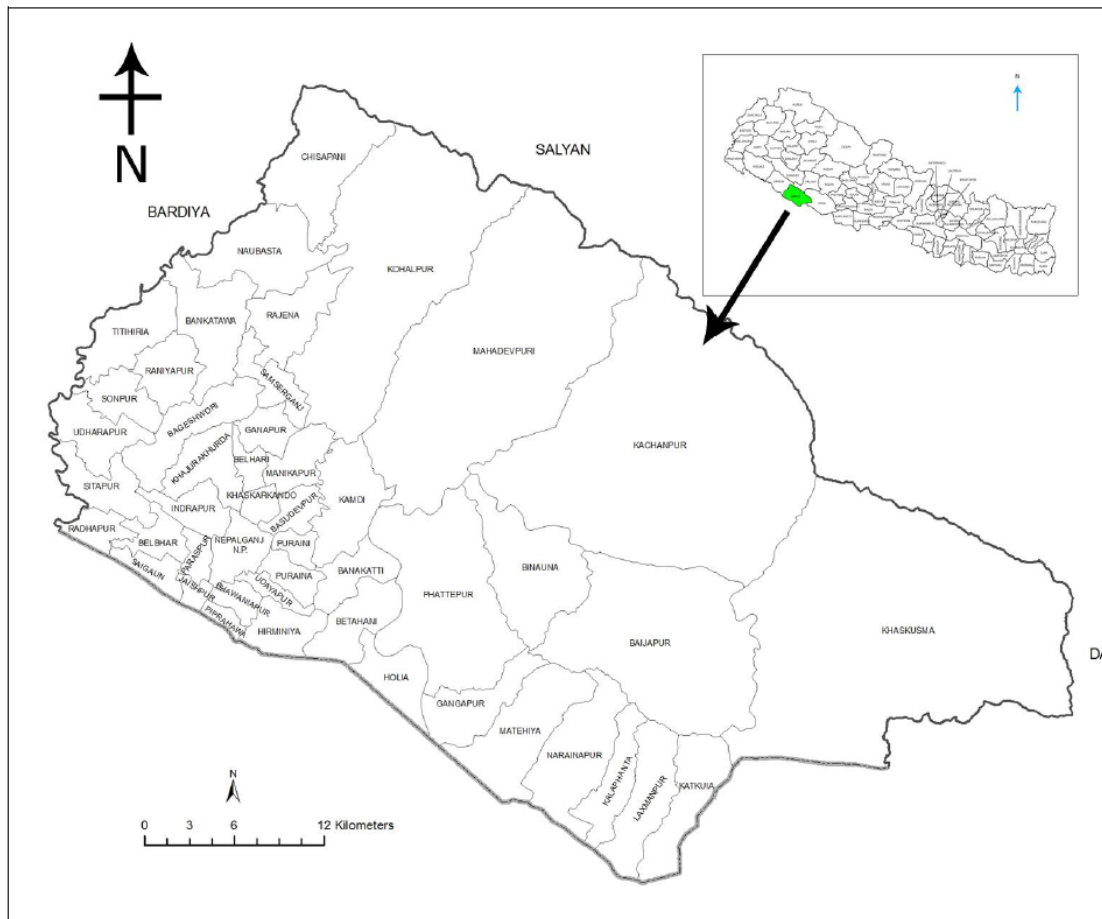


Figure 2: Map showing Banke District (Banke District profile, 2016).

### **3.1.1 LAND USE**

Banke district houses large forest area and arable land in the district accounts for about 25.35 per cent or 52.8 thousand ha (CBS, 2011). Seventy one per cent of the cultivable land is Khet (farmlands) or low land (37.8 thousand ha) and the remaining 15 thousand ha is upland area. Agriculture in the district is predominantly rain-fed with only 21.9 per cent of the cultivable land with intermittent irrigation facilities. Forests account for 50.17 per cent (0.11million ha) of total land of the district. Major ecosystems in the district are Sal forest, deciduous riverine forest, savannahs and grasslands, mixed hardwood forest, flood plain community, Bhabar and foot hills of Chure range. The major timbers in the forest are Sal, Karma, Khair and Sissoo species. Seven VDCs (Khaskushma, Kanchanpur, Mahadevpuri, Kohalpur, Chisapani, Navbasta, Rajhena) of the district are designated as the buffer zone VDCs of the national park (District profile, 2014).

### **3.1.2 WATER RESOURCES**

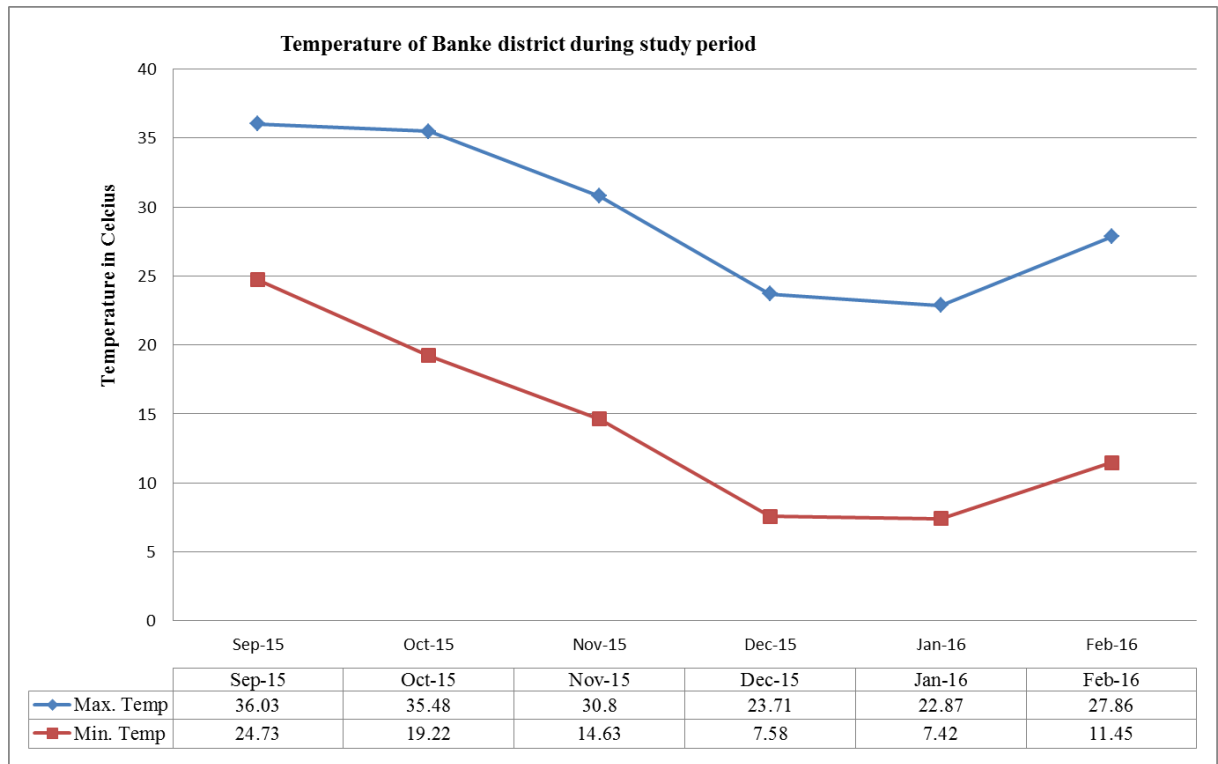
Major rivers in Banke district are Rapti, Maan, and Daduwa rivers. Other important streams and rivers of the district are Kiran, Rohini, Jhinhari, Gaduwa, Khairi, Gothari, and Jethi. The major rivers and other rivulets flows through 24 VDCs providing access to some forms of irrigation while also putting the villagers at the risk of flooding. In addition to that some of the lakes supplying water to the district are Raani, Waterpark taal, and Kantipur. Banke has been exploring its groundwater resources including that for shallow tube-well irrigation.

### **3.1.3 CROPS**

Major cereal crops produced in Banke are paddy, wheat, corn, lentil, horse gram, mustard, potatoes, mangoes, and banana. The district is also known for its herbs production. Major herbs cultivated in the district are chamomile and menthe (District profile, 2014). Total cereal produced in the district was 0.16 million while paddy and oilseed production in the district was 1,09,226 metric tons and 10,915 metric tons; respectively in 2012/13. Total vegetables production in the district including potatoes was over 0.12 million tons in the same year. Mangoes and bananas are also major agricultural product of Banke (District profile, 2014).

### **3.1.4 TEMPERATURE**

May is the hottest month (37.51°C maximum temperature averaged over 1983-2013) and January is the coldest (7.38°C min temperature averaged over 1981-2013) month in Banke district. December, January and February are the coldest months: the minimum temperature ranges from 5.89 to 12.62°C and the maximum temperature ranges from 15.8°C to 28.9°C during these months. April, May and June are the hottest months and the maximum temperature ranges from 35.42°C to 40.45°C while the minimum temperature recorded at Khajura station during these months' ranges from 15.00 to 28.6°C (DDC, 2014).



**Figure 3: Mean Monthly Maximum and Minimum Temperature Recorded during study period (September 2015- February 2016) at the Nepalgunj Metrological Station, Banke**

### 3.1.5 PRECIPITATION

Average annual rainfall received in the district is 1368.73mm and DHM records shows the lowest of 822.4 mm in 1996 and a maximum of 2429.2 mm in 1981. Monthly average rainfall received ranges from a minimum of 4.7 mm in the driest month November to 412 mm in the wettest month, July. Maximum rain falls in the months of June and July that ranges from 115 to 1079.9mm. Average rainfall observed over 1973 through 2012 ranges from 405.97 to 587.54mm (DDC, 2014).

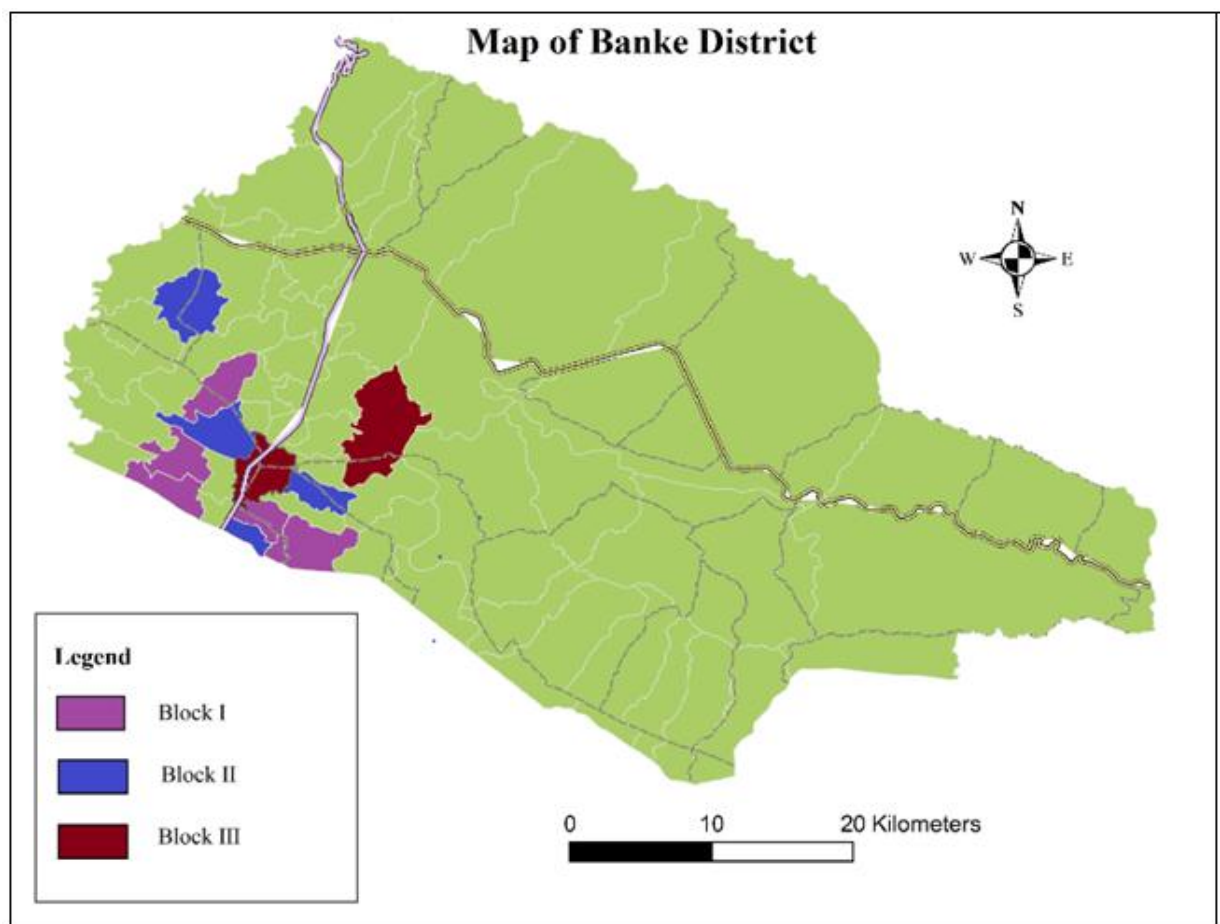
### 3.2 MATERIALS

- Measuring Tape
- GPS (Global Positioning System)
- Binocular (Olympus 10 \*50 DPS I)
- Camera
- Questionnaires

### 3.3 METHODS

#### 3.3.1 RECONNAISSANCE SURVEY AND SITE SELECTION

A preliminary survey was carried out from 12 September to 27 September 2015 to find out the entire potential habitat of Sarus Crane and to save time for the actual research. Discussions were made with experts and staffs of District Forest Office and local people to find the distribution and abundance of the Sarus Crane. Literature review, relevant articles, journals were also studied to collect the secondary data on Sarus Crane.



**Figure 4: Map showing potential sites of study area**

#### 3.3.2 BIRD SURVEY

Population status and habitat suitability of Sarus Crane were determined by direct observation through trial transect surveys in its all potential habitat of district which was carried out from 1 October 2015 to 30 January 2016. During the survey, the entire potential habitat of study area was divided into three blocks which comprises farmlands as block I, wetlands as block II and grasslands as block III. A total 75 transects of each



2.5 km were randomly selected. Out of 75 transects 30 on farmlands, 25 on wetlands and 20 on grasslands.

Trial transects are often used to census bird population (Sunder, 2005). Because of low level of traffics on the roads in the study area, it was assumed that there was no disturbance on the Sarus Crane. Trial transects surveys were carried out from 1 October 2015 to 30 January 2016 by motorbike, rickshaw and foot walk for reaching the potential habitat of Sarus Crane. Any Sarus Crane observed with the necked eye and/or with binoculars within 1000m on either side of transects were recorded. Regular surveys were conducted in the morning between 6.00-10:00 hours and evening 14:00- 17:00 hours during the study period. Since the Sarus Crane is a huge bird and visible from a distance, therefore the counts were accurate survey. Information on the number and habitat types of each location of Sarus Crane was recorded. The total available habitat area of Sarus Crane was 375 km<sup>2</sup> which comprises of open area of farmlands, wetlands and grasslands. Population density of Sarus Crane was determined by using the following formula.

$$\text{Population density of Sarus Crane} = \frac{\text{Total number of Sarus Crane observed}}{\text{Total Available habitat area}}$$

### **3.3.3 HABITAT SUTABILITY**

#### **3.3.3.1 HABITAT CLASSIFICATION**

The entire habitat of the study area had been classified into different category on the basis of vegetation structure and land cover types. Three types of habitats; farmland, wetland and grassland had been recognized in the study area. Geographical information system software ArcView 9.8 was used for spatial data analysis.

#### **3.3.3.2 HABITAT USE**

The habitat use of the Sarus Crane was evaluated in farmland, wetland and grassland. The presence of Sarus Crane was determined through transects surveys. The habitat preference was analyzed by using habitat preference rating index (HPI). HPI was prepared by dividing the percentage of animals observed in each habitat types by percentage to transect traversed in each habitat (Mishra, 1982).

$$\text{HPI} = \frac{\text{Percentage of animals observed in habitat type}}{\text{Percentage of transect traversed in each habitat type}}$$

### 3.3.4 QUESTIONNAIRE SURVEY

A set of questionnaires was prepared with several options for local people, farmer regarding their attitude on Sarus Crane. Questionnaire survey was conducted by individual questionnaire method. Prior to survey, respondents were briefed about the purpose of the study. Questionnaire deals about the Sarus Crane population Status and habitat suitability, threat and conservation issues. Survey was carried out in the study area in all potential area of Sarus Crane habitat for knowing the perception of local people regarding its population status. The questionnaire surveys were conducted in Piprawa, Bhawaniyapur, Hirminiya, Puraina, Saigaun, Paraspur, Khajura, Kamdi, and Raniyapur. Total household of these wards was 6,336. Among them 230 respondents were selected randomly for survey.

### 3.3.5 DATA ANALYSIS

Primary and secondary data collected from the field were saved in Excel and field data were analyzed in Rstudio while questionnaire were analyzed in SPSS. SPSS analysis was done to find the frequency and percentage for the questionnaires.

#### 3.3.5.1 VARIANCE TO MEAN RATIO ( $\frac{S^2}{\bar{X}}$ )

Data of Sarus Crane recorded in each habitat type were used to determine distribution pattern. The distribution pattern of the Sarus Crane was calculated by variance to mean ratio (Odum, 1971) which is based on the fact that in Poisson distribution, the variance ( $S^2$ ) is equal to the mean.

If  $\frac{S^2}{\bar{X}} < 1$ , distribution is uniform

If  $\frac{S^2}{\bar{X}} = 1$ , distribution is random

If  $\frac{S^2}{\bar{X}} > 1$ , distribution is clumped

#### 3.3.5.2 LOGISTIC REGRESSION MODEL

Logistic regression model was used to test the significant between the distributions of Sarus Crane in different habitat types (Habitat<sub>1</sub> = Grassland/ Habitat<sub>2</sub> = Farmland/ Habitat<sub>3</sub> = Wetland) using R<sub>studio</sub>.

## 4. RESULTS

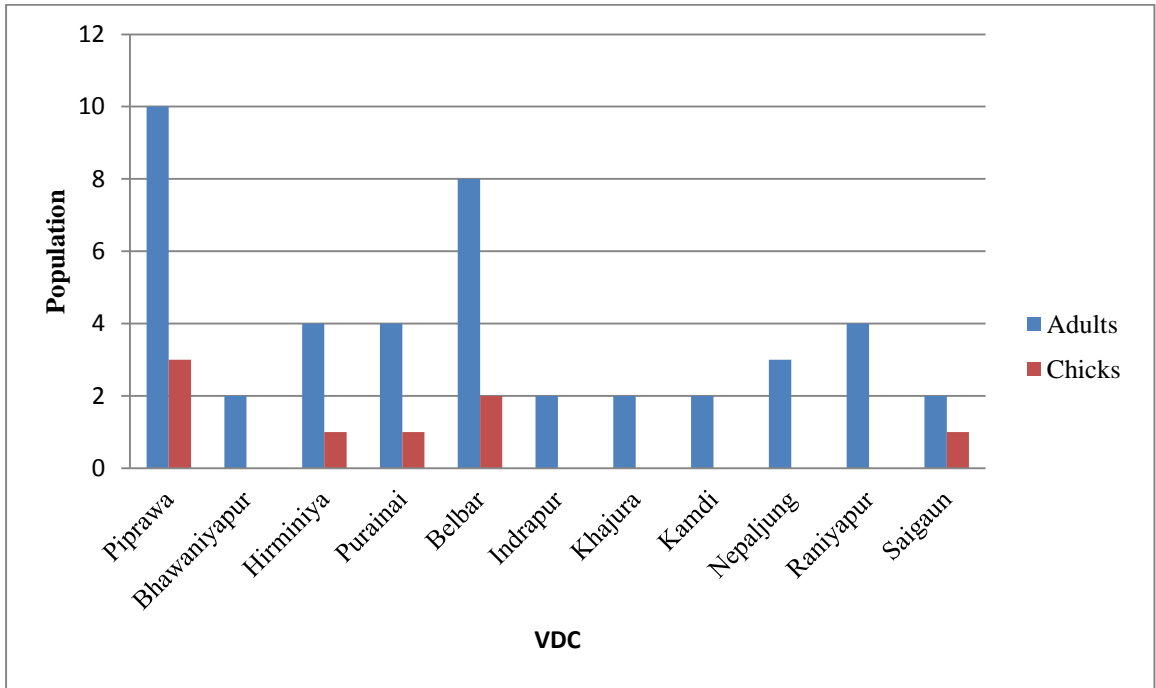
### 4.1 POPULATION STATUS OF SARUS CRANE

The total mean population of Sarus Crane was 12.75 individual in the study period. The total 51 number of Sarus Cranes were counted in Banke district of Nepal, out of them 43 were adults and eight were chick.

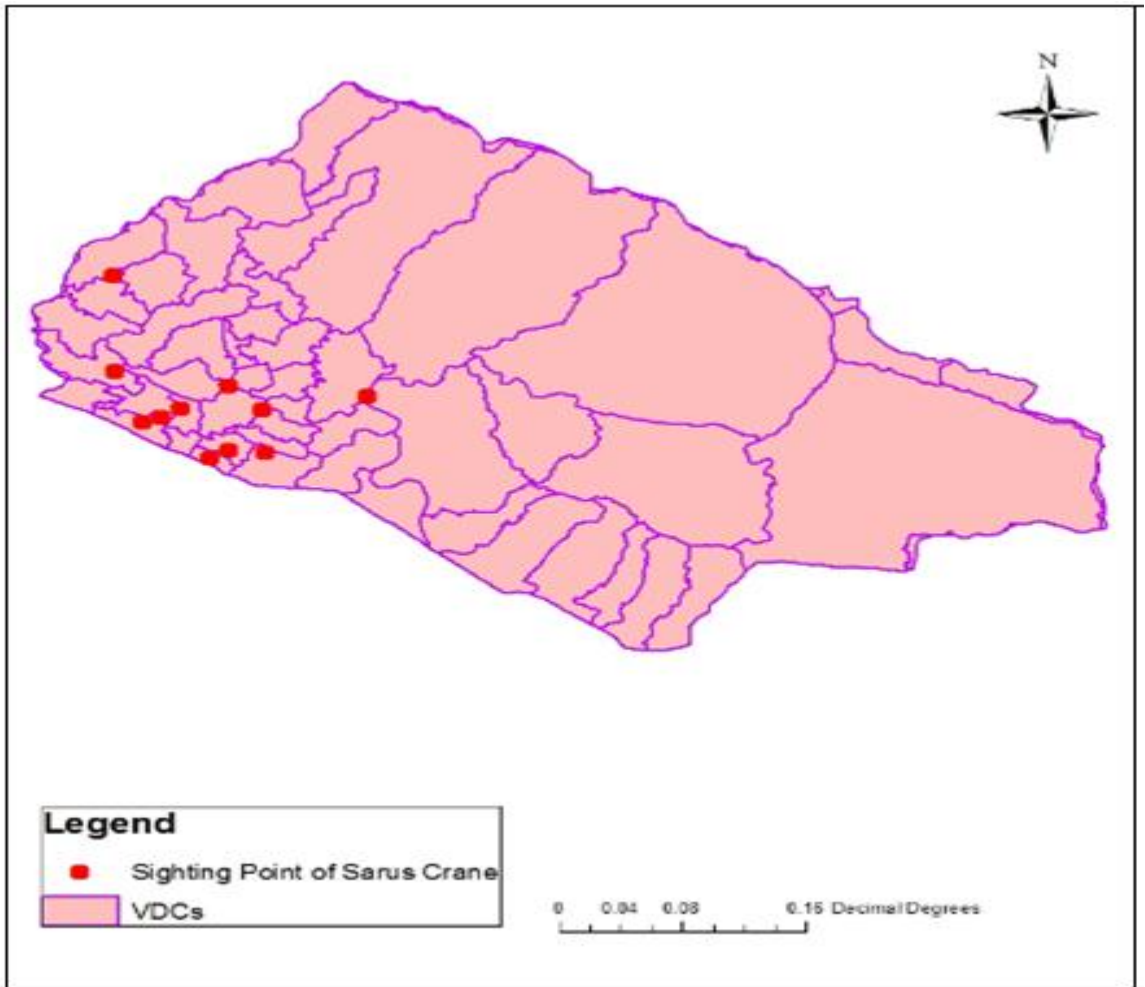
The estimated population density of Sarus Crane was 0.136 individual in per Sq. km. During the study period, Sarus Cranes were observed in single, pair and families.

**Table 1: Number of Sarus Crane Recorded in Different VDC's**

VDCs	Adults	Chicks	Total
Piprawa	10	3	13
Bhawaniyapur	2	0	2
Hirminiya	4	1	5
Purainia	4	1	5
Belbar	8	2	10
Indrapur	2	0	2
Khajura	2	0	2
Kamdi	2	0	2
Nepaljung	3	0	3
Raniyapur	4	0	4
Saigaun	2	1	3
<b>Total</b>	<b>43</b>	<b>8</b>	<b>51</b>

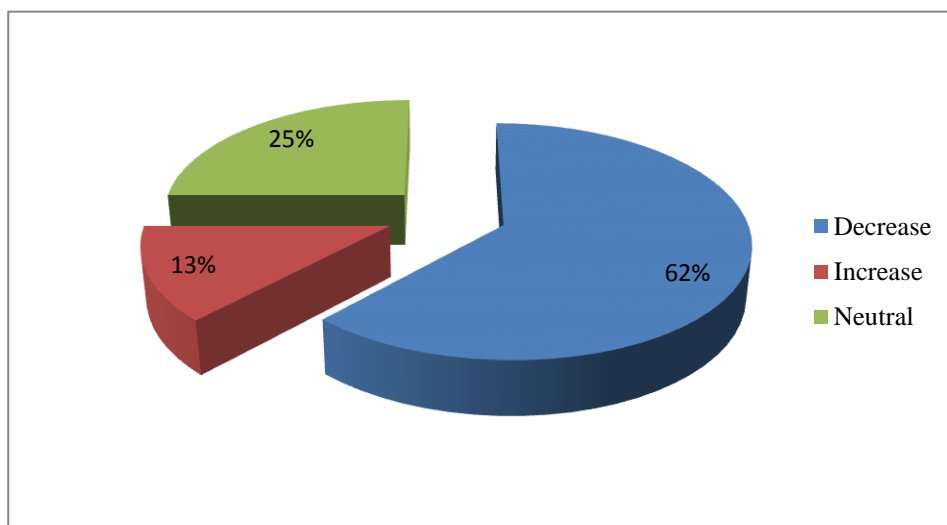


**Figure 5: Population of Sarus Cranes in the study area area VDC**



**Figure 6: The study area where Sarus Crane was observed**

From the questionnaire, 62% of respondents agreed with decrease in population of Sarus Crane in their area.



**Figure 7: Population status of Sarus Crane observed**

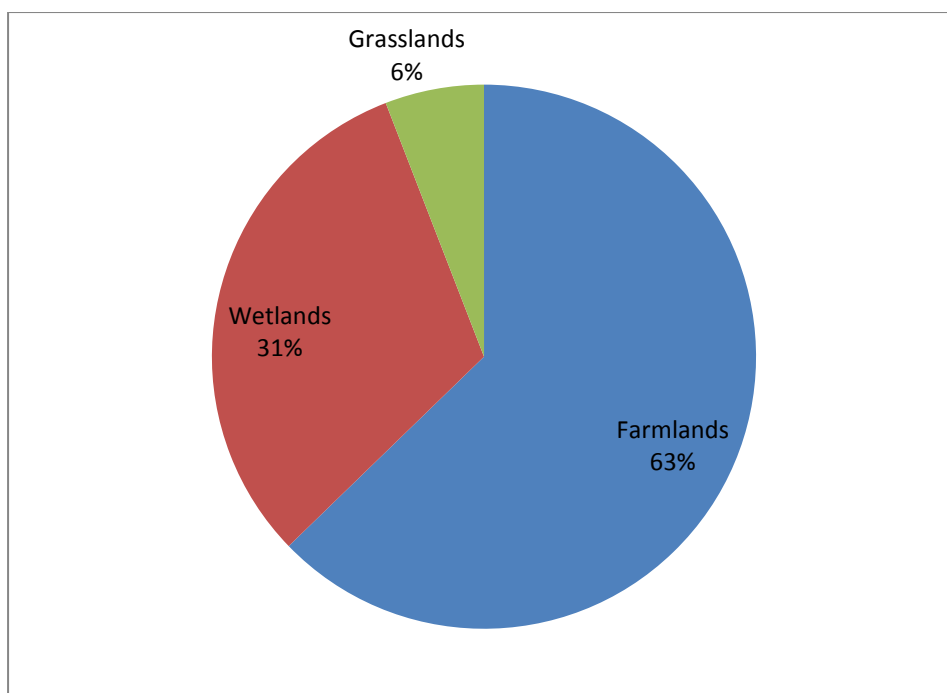
The distribution pattern of the Sarus Cranes in Banke district showed clumped pattern ( $S^2/\bar{x} = 2.63$ ). The variance/mean ratio was found to be significantly greater than 1. So uneven distribution of Sarus Crane was found.

#### **4.2 HABITAT SUITABILITY**

The number of sarus cranes sighted within this survey varied, according to habitat types. Among various habitat types, 62.75% of Sarus Cranes were sighted in farmlands, 32% were sighted in wetlands and 5.88% in grasslands.

**Table 2: Frequency of Habitat use by Sarus Crane in Banke district**

Habitat of Sarus Crane	Total number of Sarus Crane
Farmlands	32
Wetlands	16
Grasslands	3
<b>Total</b>	<b>51</b>



**Figure 8: Habitat used by Sarus Crane in Banke District**

#### **4.2.1 HABITAT SUITABILITY OF SARUS CRANE**

Coefficients:

	Estimate	Std. Error	z value	Pr (> z )
(Intercept)	-1.099	1.155	-0.951	0.3414
Habitat2	3.497	1.557	2.246	0.0247 *
Habitat3	-1.281	1.246	-1.028	0.3038

---

Signif.Codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

From the analysis, farmland was positively significant ( $p=0.0247$ ) so farmland was suitable for Sarus Crane during my study.

#### **4.2.2 HABITAT PREFERENCE RATING INDEX**

The habitat preference rating index also showed the highest preference towards farmlands (1.57) followed by wetlands (0.96) and grasslands (0.22) (Table, 3)

**Table 3: Sarus Crane Habitat Preference Index (HPI)**

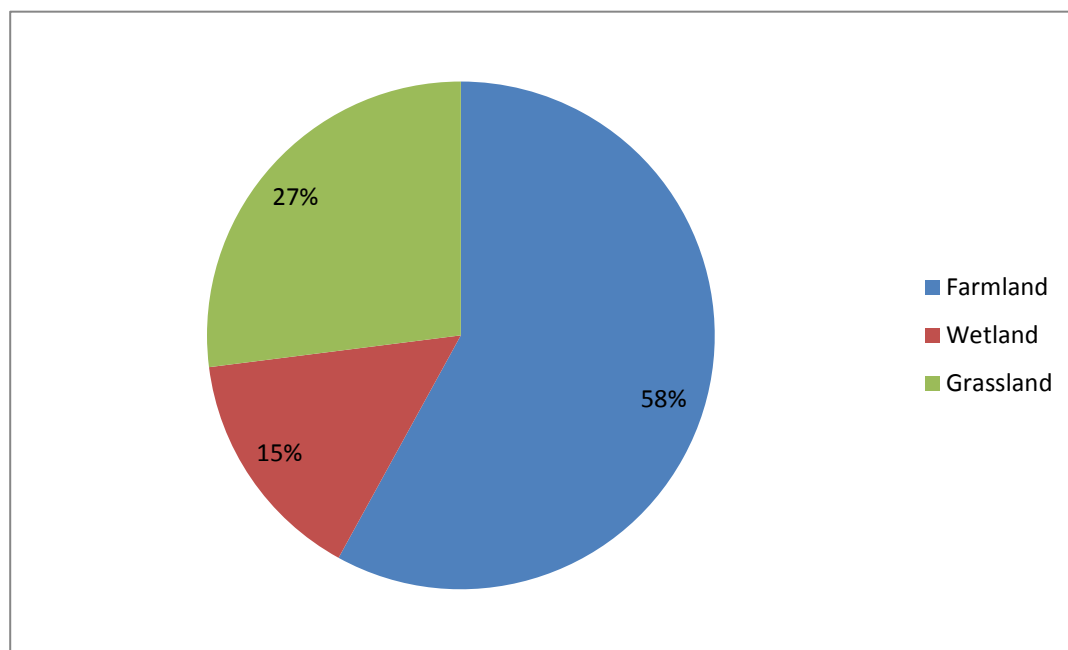
Habitat Type	No. of Sarus Crane	X*%	Y#%	HPI <sup>^</sup> (X/Y)
Farmland	32	62.75	40	1.57
Wetland	16	32	33.34	0.96
Grassland	3	5.88	5.88	0.22
<b>Total</b>	51			

\*X = Percentage of bird observed in each habitat types.

#Y = Percentage of transect traversed in each habitat type.

<sup>^</sup>HPI = Habitat preferences rating index.

As my result 58% of the respondents also had seen Sarus Crane in Farmland.



**Figure 9: Habitat used by Sarus Crane according to the respondents**

#### **4.3 CONSERVATION THREATS TO SARUS CRANE**

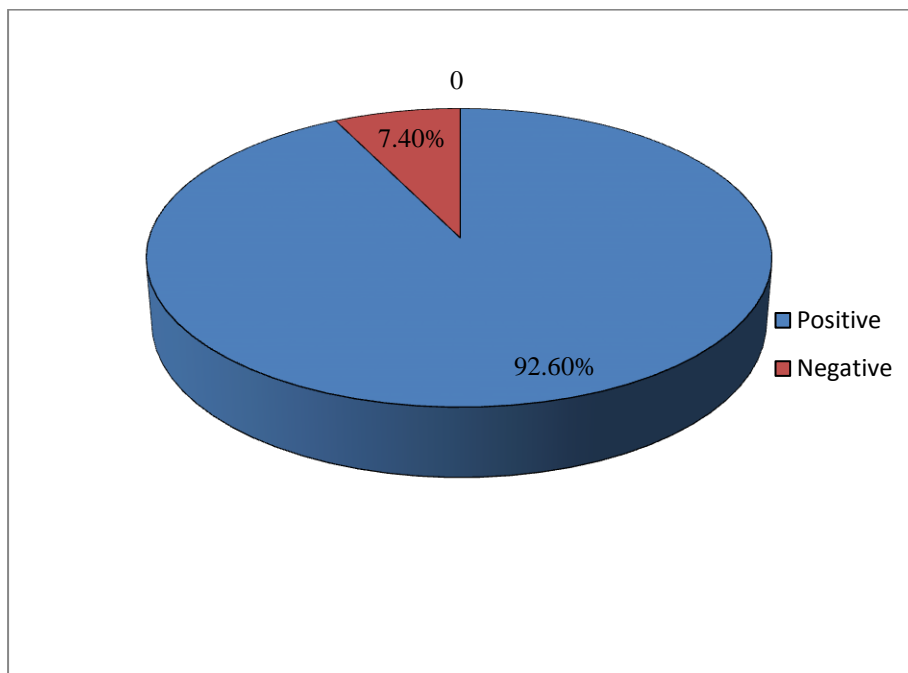
Several threats were identified to the existence of Sarus Cranes in the study area. The major threats to the survival of Sarus Cranes in the study area were habitat destruction, drying of wetlands, destruction of natural wetlands, conversion of agricultural and wetlands for different industries, dam, road construction, stealing of eggs, people hunting

for meat. The hunting of Sarus Cranes and stealing of eggs mainly by Muslim community was reported by the respondents. Among 230 respondents, 73.5% agreed with stealing of eggs of Sarus Crane, 6.1% agreed with the tradeoff of bodies of Sarus Cranes for meat and remaining 20.4% were unknown about the threats in the study area.

Farmers actively used pesticides and fertilizers on farms for agricultural production, which cause food contamination and reduced the food availability for Sarus Crane. In the study area, 54.3% of local people reported that they know about pesticide is harmful but remaining did not know but are still using pesticides. During questionnaires, 71.3% of people know that Sarus Crane is rare in Nepal and 21.7% people were unknown about these species.

#### 4.3.1 LOCAL PEOPLE ATTITUDE TOWARDS SARUS CRANE

During the questionnaire survey to 230 respondents, 92.6% of people showed positive response towards Sarus Cranes and remaining 7.4% have negative attitude towards these species in the study area because they used to damage crops by different activities like foraging and nesting behavior in the agricultural fields so many of them wanted to eliminate the Sarus Crane which was one of the threats to Sarus Crane at Banke district.



**Figure 10: Local people attitude towards Sarus Crane**



## 5. DISCUSSION

### 5.1 POPULATION STATUS OF SARUS CRANE

Sarus crane is a social, omnivorous and monogamous bird and during study period they have been seen mostly in pair, flocks, rarely in solo condition. Piprawa, Hirminiya, Puraina, Belbar, Raniyapur were considered as an important sites for Sarus Crane. Rapti river, Maan khola, Puraniya lake, Tedhi lake, Dhawa lake fully supported the relatively good number of Sarus Crane.

The distribution of Sarus Crane in Banke district was uneven or clumped as studied by Sharma (2006) due to uneven distribution of resources such as food, water and shelter and human settlements. Clumped pattern of distribution is common in nature, almost the rule when individuals are considered (Odum, 1971).

There have been several studies on the population of Sarus Cranes in Nepal. Most of the studies have been done in Rupandehi and Kapilvastu District of Nepal. Previous survey in 1995 and 1996 which was carried out by the Pratima Shrestha in Rupandehi and Kapilvastu district. She used line transect method for the counting only those accessible road where the vehicle could reached but present survey used direct observation method in its all potential and its presence area. She counted 98 and 93 individual in Rupandehi district and 30 and 38 individual in Kapilvastu district in 1995 and 1996 respectively. In a 1999 survey, 50-70 Cranes were found in Nepal. Gosai *et al.* (2016) counted the population of Sarus Cranes in Rupandehi District and found 143 Sarus Cranes, out of the those 69 male Cranes, 68 female cranes, 2 juveniles and 4 were unknown. Aryal *et al.* (2008) reported that the total available habitat of Sarus Crane in Rupandehi and Kapilvastu district was 868 sq. km and 938.04 sq. km respectively; and found total 100 number of Sarus Crane in Rupandehi district, out of them 76 were adults and 24 were chick and in Kapilvastu district, 68 Sarus Cranes were counted, out of them 55 were adult and 13 were chick. Whereas, the total available habitat of Sarus Crane in Study area was 375 sq. km and found 51 number of Sarus Cranes among which 43 were adults and 8 were Juvenile Cranes. The population density of Sarus Cranes in Banke district was 0.136 individual per square km. However, the density of Sarus Cranes in Rupandehi district presented by Gosai *et al.* (2016) was 4.2 individuals per square km which was higher than my study area. The population density of Sarus Cranes in Rupandehi and Kapilvastu district carried out by Aryal *et al.* (2008) was 0.1152 and 0.0725 individual per square km. This discrepancy could be the difference in the area covered during field observation, data generation, and calculation methods.

Temporal variation in the population of Sarus Cranes was observed in the area. In a 1999 survey, 50-75 Cranes were found in Nepal (Suwal, 1999). According to Shrestha (1996), the Sarus Cranes population in Rupandehi district was 128 in 1995 and 131 in 1996. Other studies have shown that the Sarus Cranes population in Rupandehi district was 100 in 2008 (Aryal, 2008), and 140 individuals in 2011 (Gosai, 2011). The difference in the

number of Sarus Cranes reported in these studies may be because of discrepancies in the methodology used by each researcher, coverage of the study area, or season of the study.

## **5.2 HABITAT SUITABILITY OF SARUS CRANE**

The Sarus Cranes were observed in pair, families and flock in the habitat consisting of farmlands, wetlands, grasslands. Sunder (2000) also reported that the mosaic of wetlands and agricultural fields had perhaps contributed to healthy population of Sarus Crane in single, pair and families in the districts of Etawah and Manipur in Uttarpradesh, India. As my results, Sarus Cranes preferred paddy fields (Sundar, 2000; Sundar and Chaudhary, 2003), farmlands (Aryal, 2009), agriculture fields (Mukherjee *et al.*, 2002) but some researcher (Gole, 1989; Vyas, 2002; Yassen *et al.*, 2013; Jha and Mckinley, 2014) found the Sarus Cranes preferring the natural wetlands as their habitats. The difference in these studies may be because of presence of large natural wetlands as compared to my study area and also may be due to large deforestation by the people who migrated to study area from North-South in the past decade and converted the forest land to farmlands in the study area.

In Nepal, Sarus Cranes used more farmlands than wetlands for both nesting and roosting (Shrestha, 2015; Poudel, 2009; Aryal, 2004; Shrestha, 1996; Suwal, 1994) which is similar to my research results. In kapilvastu district, 51 Sarus Cranes were counted in farmlands and 17 in the wetlands whereas 67 Sarus Crane in the farmlands and 33 in wetlands in the Rupandehi district (Aryal *et al.*, 2009). In addition 32 Sarus Cranes in farmland, 16 in wetlands and three in grasslands from this study.

## **5.3 CONSERVATION THREATS TO SARUS CRANE**

Wetlands are the most vulnerable and threatened habitats in Nepal due to agricultural expansion and vegetation succession. Local conservation is closely associated with the wetlands in their village. But due to the lack of education they are aware of consequences of over exploitation of natural resources. It is very likely that the local people are anticipating the draining of wetlands to allow for increase in cultivated average.

Several threats are identified to the existence of Sarus Cranes in the study area. The major threats to the survival of Sarus Cranes in the study area are habitat destruction, drying of wetlands, destruction of natural wetlands, conversion of agricultural and wetlands for different industries, dam, road construction, stealing of eggs which have been also reported by other researcher (Aryal *et al.*, 2009; Gosai *et al.*, 2016; Katuwal, 2016; Poudel, 2009). Due to the destruction of natural wetlands, Sarus Cranes are inhabit to the agricultural fields and are more vulnerable than they had been past because of the greater degrees of human and Sarus conflict (sundar, 2009). As the result, the population of Sarus Crane is being threatened by drainage of wetlands, conversion of farmlands to settlements, developmental activities like houses, road construction, power lines, water pollution, predation, pesticides and fertilizers (Katwal, 2016; Birdlife international, 2016;

Jha and Mckinley, 2014; Harris and Mirande, 2013; BCN and DNPWC, 2011; Baral, 2009; Poudel, 2009; Aryal, 2004; Prentic and Shrestha, 1989; Suwal, 2002).

## **6. CONCLUSION AND RECOMMENDATIONS**

### **6.1 CONCLUSION**

Sarus Cranes are found in South-Western Terai of Banke District. The population density of Sarus Crane in Banke District was very low (0.136/km<sup>2</sup>) due to lack of suitable habitats, particularly large wetlands and excessive human disturbances in the agricultural fields. The total population of Sarus Crane was found to be 51 individuals out of which 48 were adult and eight were chick. Low chicks population may indicate declining the next generation of Sarus Crane.

The Sarus Crane was found to use all available habitats, but analysis of the proportions of available habitat and frequency of habitat use clearly indicated that the Sarus Crane preferred farmlands followed by wetlands and grasslands. Sarus Crane inhabits farmland, because of the suitability of the habitat for foraging purpose and wetland for roosting. The wetlands provide water, food, nesting and shelter to the bird. They also used the grasslands located at the edge of the river or other body.

The population of Sarus Crane is found to be declining due to land use change particularly conversion of wetlands and agricultural lands for different industries, dam, road and drainage of water, lack of awareness, over exploitation of wetland resources, disturbances in the foraging and nesting places. Some of the local people have negative attitude towards the Sarus Crane because they believe the bird destroys the cultivated paddy crop.

### **6.2 RECOMMENDATIONS**

Following recommendations were made after carrying out present study;

- The population size of Sarus Cranes in Banke District is very small and sparsely distributed; thus it is essential to monitor them to understand the population dynamics and movement.
- Government, NGO and INGO and other conservation initiatives are necessary to save these threatened species outside the protected areas. For this detail scientific studies on this ecology and monitoring in existing and new localities through cutting edge technology (e.g. Telemetry tagging, geographic information system) are necessary.
- Wetland habitat restoration/ management and awareness to local people/ community need to be increased; additionally trans boundary conservation approaches are required as Cranes are subjected to observe the local movements at border areas.
- Discouraging the use of insecticide/ pesticides and chemical fertilizer and use of biological control measurement and organic farming.

- Further, establishment of Crane conservation area by the government and crane conservation action plan are necessary for maintaining the vital population of Sarus Cranes in Nepal.

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## APPENDICES

### APPENDIX I: QUESTIONNAIRE SURVEY

#### Questionnaires for household survey

GPS record

Latitude..... Longitude.....

Altitude.....

S.N.	Questions	Responses		Code	Go to
1	District name				
2	VDC/Municipality name				
3	Ward number				
4	Surname of respondent				
5	Do you see any wetland in your village?	Yes	No		
		1	0		
6	What is the name of wetland in your village?	Specify _____			
7	Do you see any use of wetland?	Yes	No		
		1	0		
8	For what purpose do you use the wetland?	Yes	No		
	12 a. Grazing	1	0		
	12 b. Food	1	0		
	11 c. Irrigation	1	0		
	12 d. Reed and grass	1	0		
	12 e. Others	1	0		
	12f.If _____ others _____ please specify_____				
9	Have you found any loss of wetlands around your village in the decade?	Yes	No		
		1	0		
<b>Information about Sarus Crane</b>					
11	Do you know Sarus Crane?	Yes	No		
		1	0		

12	Have you seen the Sarus Crane?	Yes	No		
		1	0		
13	Where you have seen the Sarus Crane?	Yes	No		
	18 a. Wetland	1	0		
	18 b. Grassland	1	0		
	18 c. Cropland	1	0		
	18 d. Others	1	0		
	18 e. If others please specify _____				
14	What is your opinion about Sarus Crane?	Good	Bad		If good, go to 15 and if bad go to 16.
		1	0		
15	What is the reason?	Yes	No		
	20 a. Beautiful species	1	0		
	20 b. Maintaining ecosystem	1	0		
	20 c. Recreation	1	0		
	20 d. Others	1	0		
	20.e If others please specify _____				
16	What is the reason?	Yes	No		
	21 a. Crop damage	1	0		
	22 b. Harming people	1	0		
	22 c. Environment destruction	1	0		
	22 d. Others	1	0		
	22 e. If others please specify _____				
17	Where it lives in your VDC?	Yes	No		
	22 a. Farmland	1	0		
	22 b. Grassland	1	0		
	22 c. Wetland	1	0		
	22 d. Others	1	0		
	22 e. If others please specify _____				
18	Have you seen its nest in your VDC?	Yes	No		
		1	0		
19	Where have you seen its nest?	Yes	No		
	24 a. Farmland	1	0		
	24 b. Grassland	1	0		
	24 c. Wetland	1	0		
	24 d. Others	1	0		

	24 e. If others please specify _____				
20	Does it come to your VDC?	Yes	No		
	25 a. Regularly	1	0		
	25 b. Sometimes	1	0		
21	What is the main crop of the year?	Yes	No		
	26 a. Rice	1	0		
	26 b. Wheat	1	0		
	26 c. Maize	1	0		
	26 d. Sugarcane	1	0		
	26 e. Others	1	0		
	26 f. If others please specify				

22	Does it damage the agricultural crops?	Yes	No		If yes go to 28
		1	0		
23	Which crop does it damage?	Yes	No		
	28 a. Rice	1	0		
	28 b. Wheat	1	0		
	28 c. Maize	1	0		
	28 d. Sugarcane	1	0		
	28 e. Others	1	0		
28 f. If others please specify					
24	When did it damage agricultural crops?	Yes	No		
	29 a. Morning	1	0		
	29 b. Daytime	1	0		
	29 c. Evening	1	0		
	29 d. Night	1	0		
	29 e. If others please specify _____				
26	Do you need compensation when crane damages your crop?	Yes	No		If yes go to 32
		1	0		
27	What type of compensation do you want?				
28	Do you know Sarus Crane is rare in Nepal?	Yes	No		
		1	0		
29	Do you know about its population trend?	Yes	No		

	34 a. Increase	1	0		
	34 b. Decrease	1	0		
	34 c. Neutral	1	0		
30	If increase	Yes	No		
	35 a. Previous	1	0		
	35 b. Recent	1	0		
31	If decrease	Yes	No		
	36 a. Previous	1	0		
	36 b. Recent	1	0		
32	Do you know Sarus Crane is killed by humans/ animals in your area?	Yes	No		If yes go to 38
		1	0		
33	By whom?	Yes	No		
	38 a. Man	1	0		
	38 b. Animal	1	0		
34	Why Sarus Cranes are killed?	Yes	No		
	39 a. Meat	1	0		
	39 b. Trade	1	0		
	39 c. Recreation	1	0		
	39 d. Others	1	0		
	39e. If Others please specify				
	_____				
35	Do you know about the trade of Sarus Crane?	Yes	No		If yes go to 41
		1	0		
36	Which parts do people trade off?	Yes	No		
	41 a. Eggs	1	0		
	41 b. Body	1	0		
	41 c. Live	1	0		
	41 c. Dead	1	0		
	41 e. Others	1	0		
	41 f. If others please specify				
	_____				
37	Does any organization work for its conservation?	Yes	No		If yes go to 43
		1	0		
38	What are they?	Yes	No		
	43 a. INGO	1	0		
	43 b. NGO	1	0		
	43 c. Nepal government	1	0		
	43 d. Others	1	0		
	43 e. If others please specify				
39	What do you use in your field?	Yes	No		If 44 a.

	44 a. Pesticide 44 b. Herbicide	1 1	0 0		go to 45
40	What is its name?	Yes	No		
	45 a. Melathion	1	0		
	45 b. Gamoxion	1	0		
	45 c. Metacid	1	0		
	45 d. Others	1	0		
	45 e. If others please specify				
42	Do you know the idea about amount of pesticide you use?	Yes	No		If no go to 47
		1	0		
43	From whom you get an idea?	Yes	No		
	47 a. Known amount	1	0		
	47 b. According to retailer	1	0		
	47 c. According to retailer	1	0		
	47 d. Read the level	1	0		
	47 e. Others	1	0		
	47 f. If others please specify _____				
44	For what purpose do you use the pesticide?	Yes	No		
	48 a. Insect	1	0		
	48 b. Disease	1	0		
	48 c. Storing the grain	1	0		
	48 d. Others	1	0		
	48 e. If others please specify _____				
45	Do you know about pesticide is harmful?	Yes	No		If yes go to 50
		1	0		
46	Why it is harmful?	Yes	No		
	50 a. Affecting your health	1	0		
	50 b. Affecting water quality	1	0		
	50 c. Killing humans and animals	1	0		
47	In your opinion what are the life threatening causes of Sarus Crane?	_____			
		_____			
		_____			
		_____			
48	Do you have any idea for good management of it?	Yes	No		
		1	0		



## APPENDIX II: ATTITUDES OF LOCAL PEOPLES TOWARDS SARUS CRANE

### Do you know sarus crane?

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 1	230	100.0	100.0	100.0

### Have you seen sarus crane?

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 1	230	100.0	100.0	100.0

### Where you have seen the sarus crane?

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 3	135	58.7	58.7	58.7
Valid 2	32	13.9	13.9	72.6
Valid 1	63	27.4	27.4	100.0
Total	230	100.0	100.0	

### Where it live in your vdc?

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 1	134	58.3	58.3	58.3
Valid 2	32	13.9	13.9	72.2
Valid 3	64	27.8	27.8	100.0
Total	230	100.0	100.0	

### Have you seen its nest?

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 0	178	77.4	77.4	77.4
Valid 1	52	22.6	22.6	100.0
Total	230	100.0	100.0	

**Does it come to your VDCs?**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 1	153	66.5	66.5	66.5
Valid 2	77	33.5	33.5	100.0
Total	230	100.0	100.0	

**Does it damage the agricultural crops?**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 0	204	88.7	88.7	88.7
Valid 1	26	11.3	11.3	100.0
Total	230	100.0	100.0	

**Do you know about its population trend?**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 2	145	63.0	63.0	63.0
Valid 1	29	12.6	12.6	75.7
Valid 3	56	24.3	24.3	100.0
Total	230	100.0	100.0	

**Do you know Sarus Crane is rare in Nepal?**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 0	66	28.7	28.7	28.7
Valid 1	164	71.3	71.3	100.0
Total	230	100.0	100.0	

**Which part do people trade off?**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 2	14	6.1	6.1	6.1
1	169	73.5	73.5	79.6
3	47	20.4	20.4	100.0
Total	230	100.0	100.0	

**Do you know Sarus Crane is killed in your area?**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 0	227	98.7	98.7	98.7
1	3	1.3	1.3	100.0
Total	230	100.0	100.0	

**APPENDIX III: PERCEPTIONS OF LOCAL PEOPLES TOWARDS SARUS CRANE**

**Do you see any wetland in you village?**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 1	230	100.0	100.0	100.0

**For what purpose, do you use the wetland?**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 3	230	100.0	100.0	100.0

**Have you found any loss of wetlands around your village in the decade?**

	Frequency	Percent	Valid Percent	Cumulative Percent
0	21	9.1	9.1	9.1
Valid 1	209	90.9	90.9	100.0
Total	230	100.0	100.0	

**What is your opinion about about Sarus Crane?**

	Frequency	Percent	Valid Percent	Cumulative Percent
0	17	7.4	7.4	7.4
Valid 1	213	92.6	92.6	100.0
Total	230	100.0	100.0	

**Does any organization work for its conservation?**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 0	230	100.0	100.0	100.0

**What do you use in your field?**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 1	230	100.0	100.0	100.0

**Does any organization work for its conservation?**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 0	230	100.0	100.0	100.0

**Do you know about pesticide is harmful?**

	Frequency	Percent	Valid Percent	Cumulative Percent
0	105	45.7	45.7	45.7
Valid 1	125	54.3	54.3	100.0
Total	230	100.0	100.0	

**APPENDIX IV: PHOTO PLATES OF SARUS CRANE**



**Sarus Crane in Croplands**



**Sarus Crane foraging in Study Area**



**Drying of wetland in Study Area**



**Water park in Banke District**



**Flock of Sarus Cranes**



**Sarus Crane Foraging in Farmland**

**APPENDIX V: PHOTO PLATES DURING FIELD SURVEY**



**Wetland in Study area**



**Dhawa lake in Study Area**



**Field work to collect data**



**Questionnaire Survey[**



**Collecting data with local people**



**Household survey**

