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PARK PEOPLE CONFLICT:

ASSESSMENT OF CROP DAMAGE AND HUMAN HARASSMENT BY RHINOCEROS (Rhinoceros unicornis) IN SAURAHA AREA ADJACENT TO THE ROYAL CHITWAN NATIONAL PARK NEPAL

BY

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ABSTRACT

Royal Chitwan National Park in the sub-tropical lowland of Nepal is among the richest wildlife habitats on the Indian subcontinent. The park is internationally recognized as one of the last remaining habitats of the Greater One-horned Rhinoceros in the world. The park has succeeded in restoring this important animal population, but the problem of crop damage and harassment to local communities at the periphery of the Park has been increasing since the park was established in 1973. Since then rhino numbers have increased with an average annual rate of 3.4%. The habitat in the northern fringes of the park is degraded due to livestock grazing and other human activities. Consequently, agricultural crops have become a supplementary diet for the local rhino population. Besides this, injuries and harassment to local people have also become a serious problem, creating negative attitudes towards park management.

A study was conducted during the 1988/89 production year (July 1988 - February 1989) to assess the problem of crop damage and rhino harassment in Sauraha, one of the most acute problem areas in the North East sector of the Park. The study showed a total economic loss estimated at 172000 Rs., of which 68.6% occurred within a distance of 500 m (zone I) of the Park boundary. Some 100 households were affected. Highest economic loss (27.6%) occurred to rice crops, followed by mustard (21.9%), lentils (18.4%), maize (16.8%) and kitchen garden plants (12.5%). Besides, the study of harassment showed a total of 78 accidents within a short period of 10 years, 1978-88. Most accidents, about 85%, were among the Hill Matwali and Tharu people as they are most active in the agricultural fields and forests.

Physical barriers (fences and trenches) to prevent animals from moving out of the Park and into agricultural fields were ineffective due to lack of proper maintenance. Traditional means to scare off rhinos were also not effective enough to remedy the problem. Various solutions are proposed to alleviate the growing conflicts in the area.

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DEFINITIONS

district	a political administrative unit composed of Panchayats
hattisar	elephant stable
machan	a small roofed platform erected for crop guardng purpose
mukka	fire stick, mainly used to chase rhinos
panchayat	a political administrative unit including many small villages

1. INTRODUCTION AND OBJECTIVES

The Royal Chitawan National Park (RCNP) is internationally recognized for its unique wildlife, and is of special importance as one of the last remaining habitat in the world of the Greater One-horned Asian Rhinoceros, Rhinoceros unicornis (Mishra 1982).

The park is situated in Chitawan Valley in the sub-tropical lowland of the southern Terai plain, bordering India (Fig. 1). Previously the valley was densely covered with vast natural forests and savannas. Malaria was prevalent and only an indigenous ethnic group immune to this disease - the Tharus - inhabitated the jungles in relatively low numbers. Through the effects of a USAID programme, malaria was finally eradicated in the early 1960's. This opened up the area for settlement. Large tracts of the fertile valley were cleared and opened for agricultural production. His Majesty the Government of Nepal (HMG) initiated a resettlement scheme whereby poor hill people were given land for cultivation.

Since 1846 to 1950 this rich wildlife habitat had been protected as a Royal Hunting Reserve by Rana rulers. The Rana Regime came to an end in 1950. After the successful eradication of malaria, about one hundred thousand people moved from the hills and settled in the fertile areas of the valley. The wildlife and habitats were poverished due to the new settlements,

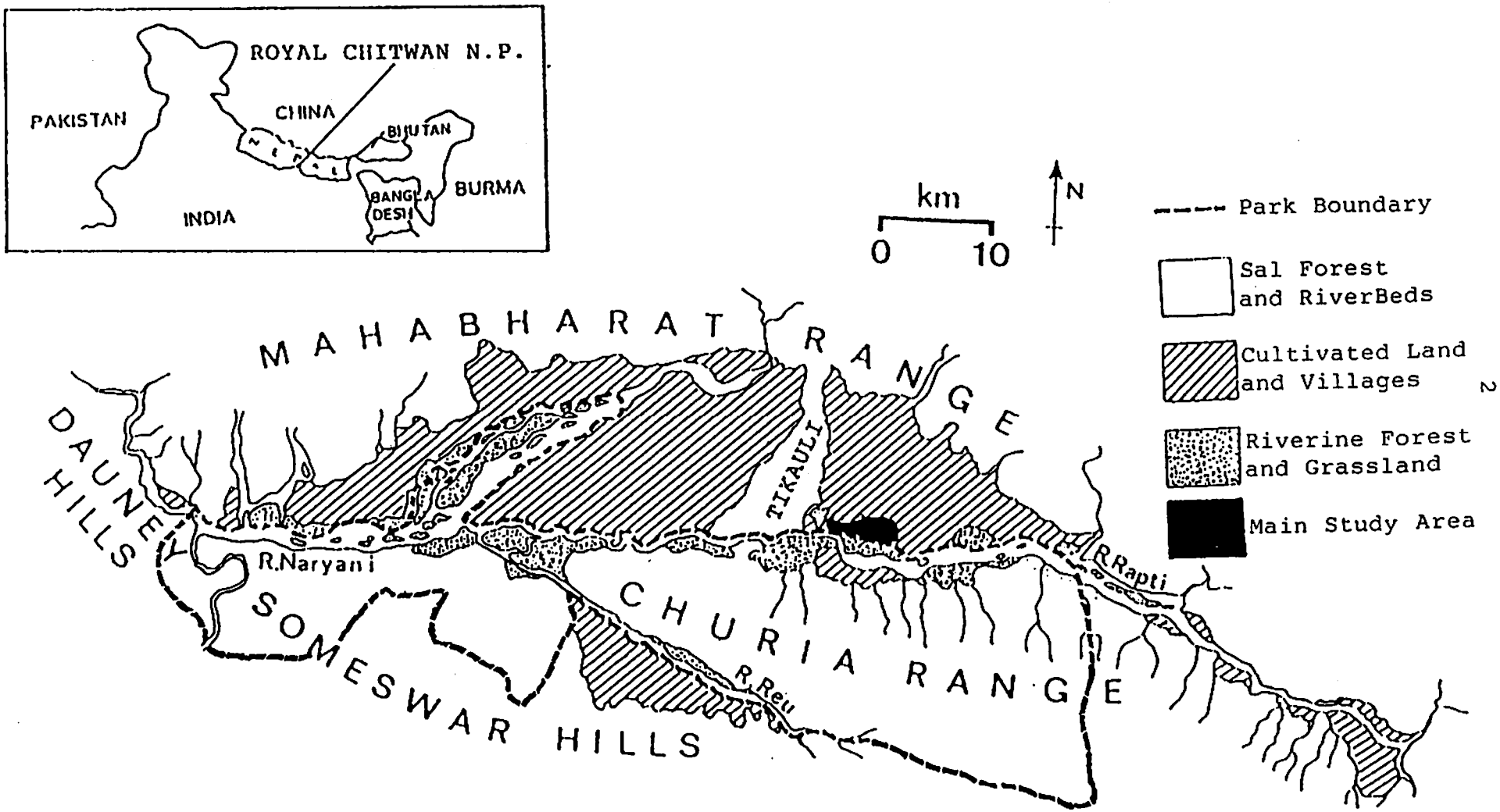


Fig. 1 Map of Chitwan Valley, Nepal, Showing Location of Royal Chitwan National Park, Main Study Area, Vegetation Cover and Land Use. (Base Map Modified from Laurie 1978 and Dinerstein and Price 1989).

expansion of agricultural land and heavy poaching (Milton and Binney 1980). Among the large mammals, rhinos were most affected. Hunting rhinoceros and the destruction of their habitat nearly eliminated the species. Maximum destruction occurred during late 1950's and 1960's. Some protected areas were proposed and demarcated already as early as 1958 and 1964, but they were never gazetted and no regulations existed to manage and protect them. In 1964 a "rhino sanctuary" was created by the late King Mahendra, and more than 22000 people were moved and resettled outside the present park boundary (Mishra 1982).

The remaining forests and savannas south of the Rapti river, including part of the Churia range, were finally gazetted and declared a National park by His Majesty Government in 1973. When first established, the park was only 544 sq.km. in size, but it was extended in 1977/78 to a total of 932 sq km. The dwindling number of rhinoceros was the main reason for establishing the National park. The population has since increased to 380-400 animals (Dinerstein and Wemmer 1988). A large share of the population inhabits the area adjacent to villages.

Since the park was established, local people's problems with the park have been growing. The wildlife, particularly rhinoceros, damage agriculture crops, while village people have almost no access to park resources. The rhinoceros leave the park and enter the agriculture field during night, causing considerable damage to crops as well as to other newly es-

tablished plantation nurseries. Besides this, harassment to humans is experienced every year. An increasing number of people, including tourists, are chased/attacked and a few are even killed by rhino attack.

The population of rhinos has increased markedly after the establishment of park. Increasing crop damage and attacks on human life are creating hostile attitudes among local people towards the preservation efforts of this species. A study of this conflict is necessary in order to build up a harmony between conservation and people residing on the periphery of the park.

This study was carried out in the adjacent village where the problem is most acute: the Sauraha area including both Bachhauli and part of Kumroj Panchayats. It attempts to quantify the amount of crop damage and human harassment and to assess remedies to minimize such conflicts. Field work covered the time period between July 1988 and February 1989 and included most of the important crop plants grown in the area.

2. THE STUDY AREA

2.1 Location and access

The Royal Chitawan National Park, (84°20' East and 27°30' North), lies in the Chitawan District in the subtropical lowlands of the Terai in the Narayani Zone, roughly sixty miles southwest of Kathmandu (Fig.2). The Park is located between the Rapti River, which demarcates the northern boundary from an in-

tensively cultivated area, and the Nepal-India border in the south. The western boundary is formed by the Narayani River, while in the east the park is bounded by forests and cultivated land. The main study area lies adjacent to the Sauraha sector of the park, henceforth called Sauraha Area (Fig. 2). This includes a total of 1372 ha of intensively cultivated land in Bachhauli Panchayat and a small southwestern section of Kumroge Panchayat. The conflict area borders the RCNP to the south, Odhara and Bagmara villages in the west, Gauhi village in the east and the Budhi Rapti river in the north (Fig. 2).

The area is accessible from Kathmandu by road to Narayangarh and further on the east-west highway to Tandi Bazar or from Kathmandu to Hetaura to Tandi Bazar, the nearest shopping centre. A seasonally motorable road runs from Tandi Bazar to Sauraha, a distance of about 6 km.

During the monsoon canoes are the main transporting device to cross both Rapti and Budhi Rapti rivers. Two foot bridges in Budhi Rapti and one in Dhungre River were established during winter. Transportation is mainly by bullock carts.

There are no local hospitals or medical centres for health care. Health assistants are available in Tandi Bazar. Recently a plan has been formulated for medical services on the local level. The plan aims to provide medical services at a minimum price for local people.

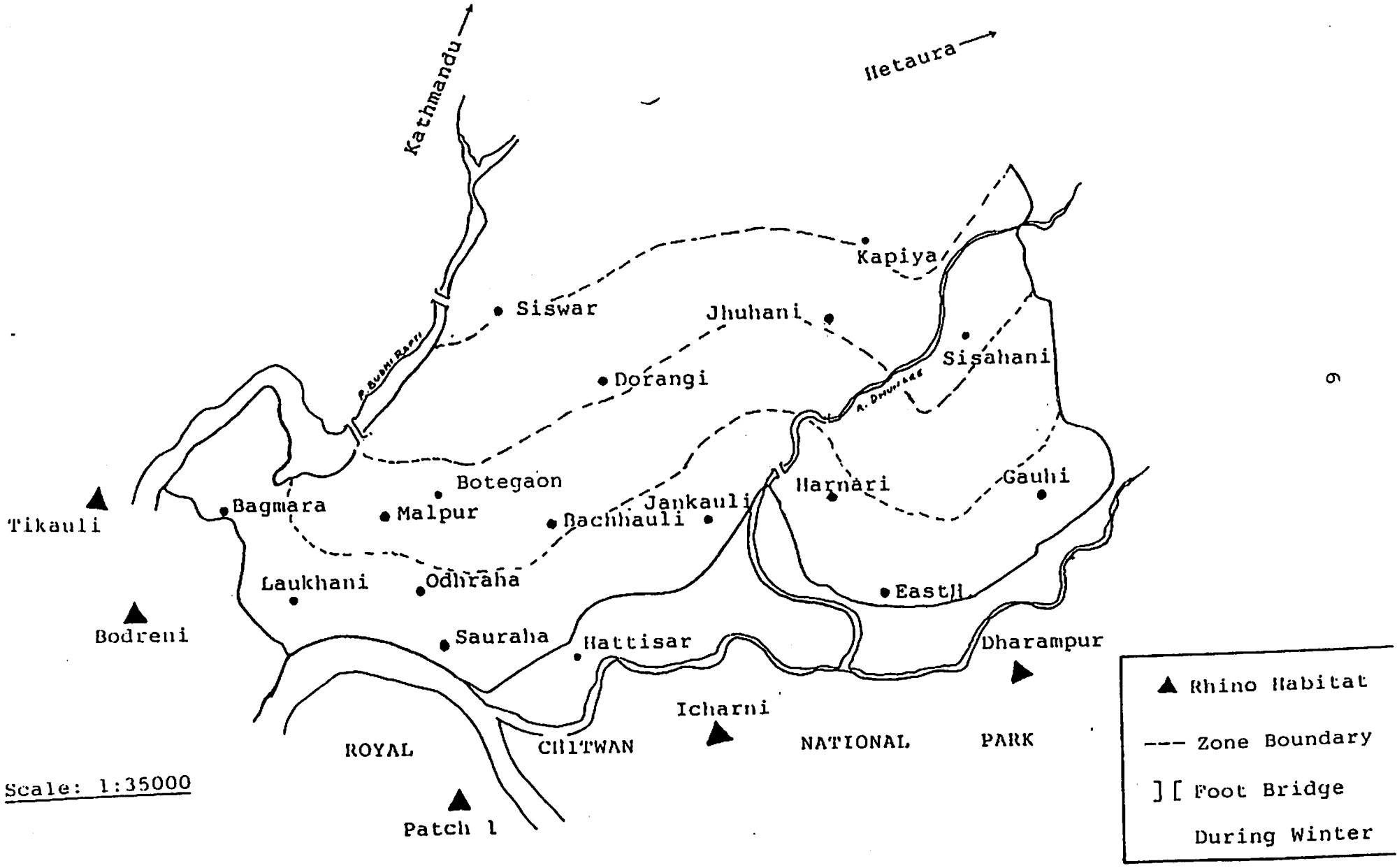


Fig. 2. Map of Main Study Area Showing Villages Mentioned in the Text

2.2 Climate

The climate is subtropical with a summer monsoon from mid June to late September and a relatively dry winter season. Temperature normally reaches a maximum in May of about 38° C and becomes slightly lower, but with smaller daily amplitudes, during the monsoon and falls progressively until January to about 7° C (Table 1).

The hot and humid monsoon extends from June to September. Then southeasterly winds bring heavy rainfall causing heavy flooding of rivers and streams. In winter, the nights are damp and cold with heavy fog during early morning. Dry cool northerly winds then blow from the great Himalayas and the Tibetan plateau, reducing day temperatures.

Table 1. Mean maximum and minimum temperatures (°C) at Rampur Agriculture Station, 26 km west of Sauraha.

	J	F	M	A	M	J	J	A	S	O	N	D
max	25.1	29.3	32.9	37.4	37.9	36.1	35.2	34.6	35.0	31.1	27.0	23.1
min	7.7	11.2	17.3	22.5	25.1	25.5	25.4	25.3	23.4	17.4	11.6	7.2

(Source: Bolton 1975.)

Rainfall pattern is unimodal. On average, there are eight consecutive dry months with less than 100 mm of rainfall and four consecutive wet months with more than 200mm rain (Fig.3). According to Laurie (1979), mean annual rainfall for the period 1973 - 1975 was 2,411.6 mm, 92% of which fell between May and September.

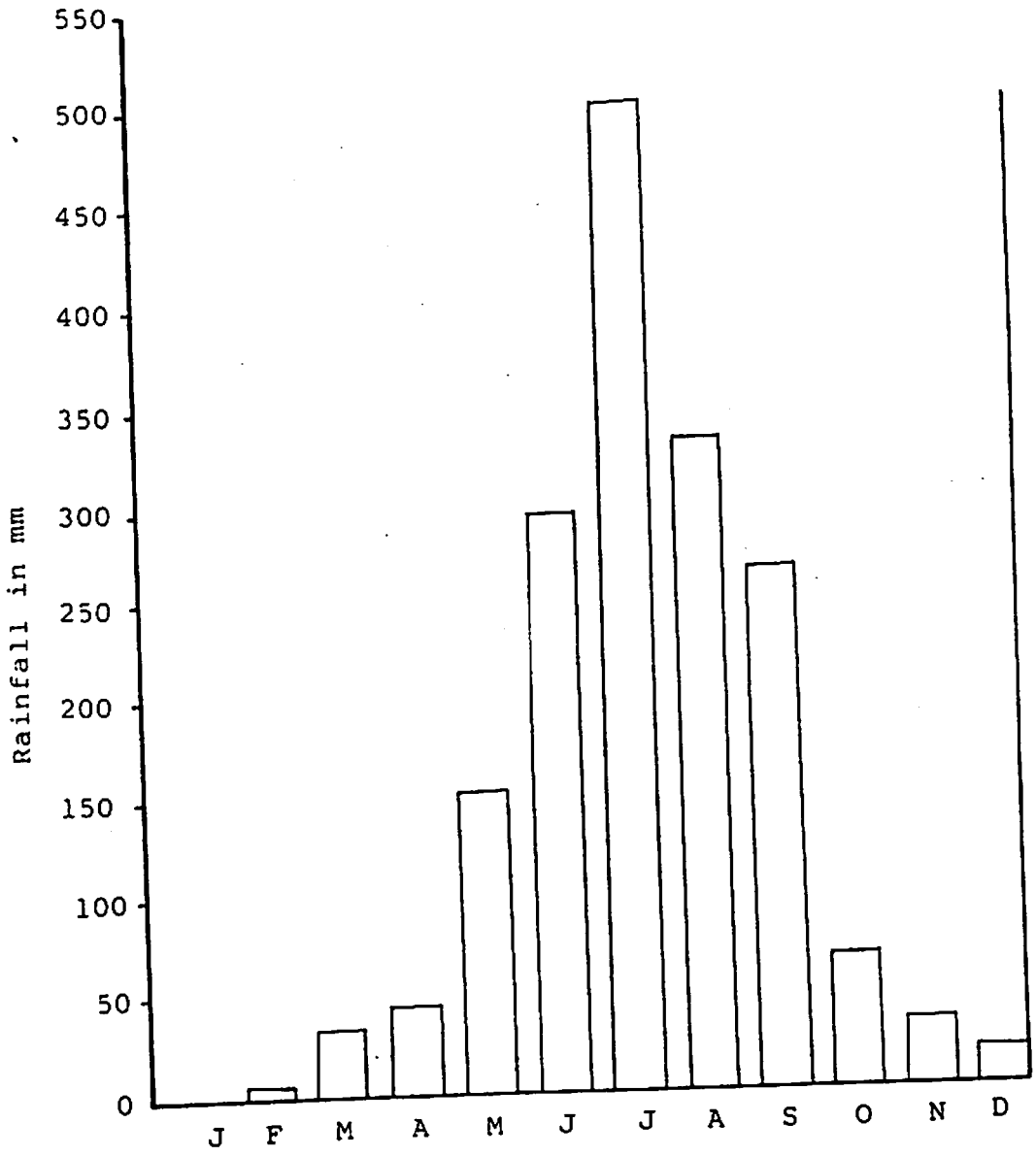


Fig. 3. Mean Monthly Rainfall

(Source: Mishra 1982)

2.3 Geology and soil

Geologically the area consists of the late Tertiary Siwalik formation. The core of the Siwalik consists mainly of sandstone, conglomerates, quartzites, shales and micaceous sandstones (Laurie 1979).

The soil of Chitawan valley is an alluvial plain and terraces developed by the three main rivers - the Narayani in the north, Rapti in the south and Lothar in the north-east. Geologically, they consist of moderately coarse to medium textured deposits underlined by fine sand and compacted gravel. The texture of the soil varies from fine sandy loam to silty clay in irrigated lowlands. Sandy loams or eroded gravelly loams are often very dark in colour in the hills (Mishra 1982). The soil is among the most fertile for agriculture in the Nepalese Terai.

2.4 Topography and Hydrology

The park is situated in a river valley along the flood plains of the Rapti, Reu and Narayani rivers in the inner Terai. The intensively cultivated Sauraha Area is almost flat and lies about 250 m above sea level. The southwest boundary is highly eroded every year by the Rapti River. Similarly, some of the areas along Dhungre and Budhi Rapti rivers are eroded during the monsoon. These two rivers irrigate the Sauraha area and its neighbouring farmlands.

Drainage in Chitawan is quite good. Permanent standing water

is almost entirely confined to small tals (oxbow lakes) and lakes in the northern part of the park.

2.5 Fauna

Royal Chitawan National Park contains such endangered species as the Great One-horned rhinoceros and the tiger Panthera tigris. Besides these, leopard Panthera pardus, sloth bear Melursus ursinus, gaur Bos gaurus, four species of deer - chital Axis Axis, hog deer Axis porcinus, sambar Cervus unicolor, and barking deer Muntiacus muntjak, - wild boar Sus scrofa, Gangetic dolphin Plananista gangeticus and two species of crocodiles - gharial Gavialis gangaticus and marsh magar Crocodilus palustris, are also important members of the fauna. Almost 35 species of mammals, over 400 species of birds, about 100 species of fish and reptiles make the park unique on the Indian subcontinent (Mishra 1982).

Due to lack of suitable habitat, virtually no wildlife resides outside the park boundary except those rhinos, chitals and wild boars which enter the agriculture fields during night to feed there. The rose-ringed parakeet Psittacula krameri and red munia Estrilda amandava are also frequently observed during maize and rice growing seasons.

2.6 Vegetation

Three major vegetation types have been studied in the park (Laurie 1979) and (Mishra 1982). Sal forest with monotypic stands

of sal Shorea robusta occupies about 70% of the park area. The homogenous sal forest is occasionally associated with a few other tree species (Terminalia spp., Bauhinia spp., Dalbergia latifolia and Bridelia retusa) and grass species, mainly Themeda caudata. In the hills, scattered Phoenix palms are conspicuous among the very sparse undergrowth, and chir pine Pinus roxburghii occurs in the tongue extending into the sal forest in the foothills. Bamboos Dendrocalamus strictus are common on the northfacing slopes of the hills.

Riverine forest occupies an area of about 7% along the water courses and islands in both Rapti and Narayani rivers. Simal Bombax ceiba, Veller Trewia nudiflora, Khair Acacia catechu, Sissoo Dalbergia sissoo, Sindure Malotus phillipinensis, Kutmiro, Litsea monopatela, Bauhinia malabarica, Butea monosperma and Careya arborea are the most common trees. Associated understory shrubs (Murraya paniculata, M.koeniqii, Callicarpa macrophyllla, Clerodendron viscosum, Coffea bengalensis, Colbrookea oppositifolia) and herbs (Ageratum conysoides, Euptorium odoratum and Oxalis corniculata) and various types of climbers (Acacia conicinna, Bridelia stipularia, Stipharia joponica and Tinospora sinensis) are also common in the riverine forest type. Grasses are sparse except in clearings and at the forest edges where tall species such as Vetiveria zizianoides, Saccharum munja and Kans S. spontaneum, and shorter species, such as Dubo Cyanodon dactylon, Seteria pallidefusca, Paspalidium flavidum, and Digiterium setigera occur (Laurie 1979).

Grasslands, extending along the rivers and those surrounded by forest patches, are the most preferred habitats by most of the wildlife in the park. Kans, Baruwa S. bengalensis, Phank Norenga porphyracorma, Ooreli Themeda arundinesia, Phragmitis karka and Typha elephantina are the most common perennial tall grasses. Siru, Imperata cylindrica, a universal weed, forms large grassland patches within the forests. This species is mainly used for roofing houses in adjacent villages. The lower needlelike part of this species is used to make brooms by local Tharu communities. Short grasses such as Dubo, Seteria pallidefusca, Paspalidium flavidum and Kuro Chrysopogon aciculatus grow in the open fields. Hydrilla verticillata, Ceratophyllum demersum and Utricularia aurea are common aquatic plants in the pools.

These three main habitat types are restricted now only to the park. All forests nearer to rural settlements are seriously degraded and depleted (Edson et al., 1988). Most of the Chitwan valley has been cleared for cultivation. Only a few species of fodder trees are found along the field boundaries, mounds and unfertile eroded areas. Dabdabe Garuga pinnata, Kutmero Litsea monopetla, Veller, Tanki Bauhinia purpuria, and Bamboos are the main fodder species in the villages. A few Pipal Ficus riligiosa, Khanyu Ficus cunia, Nim Azadirachta indica, Ginderi Premna integrifolia, Khasreto Ficus hispida and Bakena Melia azedarach are also found. Grazing areas are mainly occupied by Kuro, Siru, Dubo and a common herb species, Tapre Cassia tora. A

few species of short grass, sedges and herbs grow among the crops and in the field during the fallow period. The more common species include Capillipedum assimile, Dadylocatenium aegyptium, Echinochloa colona, Eleusine indica, Heteropogon contortos, Desmotachya bopinnata, Scirpus sp., Chenopodium album, Alternanthera sessilis, Cynoglossum glochidiatum, and Euphorbia hirta (Laurie 1979). Most of the palatable plant species near the northern boundary of the park have been replaced by unpalatable herbs and shrubs due to overgrazing by livestock.

2.7 Land use

A total of 12167 people (Source: Malaria Eradication Office, Bharatpur) inhabit the area. The population is mixed. Besides the indigenous Tharus, hill-migrated Matwalis and Brahmins constitute a major part of the population. 82% of the households in Doringi and 52% in Sauraha belong to the Tharu ethnic group (Edson et al. 1988).

Agriculture is the main economic activity. Agriculture and land use pattern is similar to most of the inner Terai. Most of the cultivated areas are irrigated. Irrigation channels are dug annually from major water sources. Milton and Binny (1980) described the seasonal cycles of planting and harvesting in nearby Padampur area. Crops and their growing seasons are listed in Apendix 1. Rice, a main crop, is planted in June-July and harvested in November-December. It is grown in irrigated lowlands and rainfed fertile lands. Maize is planted prior to the monsoon

mainly in dry uplands, and is harvested in August- September. Mustard and Wheat are the main winter crops. They are planted immediately after the rice harvest and are harvested after 4 - 5 months. Wheat and some other corps (millet, common buckwheat) are not cultivated widely due to damage problems from wildlife. Lentils are grown as a sequential crop mixed with rice or mustard. Some local variety of beans are grown together with maize. Black gram and soyabean are mainly grown in the terrace mounds during the rice planting season, but both are harvested prior to rice.

Farming techniques are primitive, the work mainly being done manually and by draught animals. Some farmers use tractors for soil preparation to grow mustard and rice. Farm manure is used as fertilizer. Besides this, most of the farmers now use chemical fertilizers and pesticides. Ash from firewood burning is used as a caterpillar repellant in the kitchen gardens. Leaf mustard, potato, cauliflower, egg plant and radish are here the most common vegetables.

Stock includes domestic cattle and water buffaloes which provide both milk and bullocks for ploughing and pulling bullock carts. Goats, sheep, chickens and ducks provide meat. Fish from rivers and snails from ghols (swamps) and small ditches are also major sources of protein, especially in Tharu communities.

Farmers have already begun to experience a serious shortage of fodder, firewood and other forest-based products. Recently,

two forest nurseries have been established in Bachhauli Village Panchayat. These have been in production for the last few years and provide seedlings (sissoo, khair, simal and bamboo species) for local plantations on eroded and unfertile lands and along the park boundary where farmers have much wildlife damage. The majority of farmers who own very little farmland, do not want to allocate their agricultural fields for plantations. Especially Tharu communities which normally consist of large families are against plantations. They argue that plantations in the middle of the field increase pests, mainly parakeets and red munia, and that this might also provide good shelter for rhinoceros during the maize growing season.

3. MATERIALS AND METHODS

3.1 General methodology

Of the time allotted for field work, a few weeks were spent in Kathmandu for collecting information, literature and equipment necessary for the study.

The work started by visiting local people and monitering the movement of rhinos with radio telemetry at night. Especially farmers close to the park boundary were a bit curious about my work. It took a few days to make them understand the purpose of the study. Panchayat leaders, park authorities, hotel owners and selected old, experienced farmers from different villages were

visited and the work discussed with them. Households for interviewing people in different zones were selected randomly to assess specific problems, 35 in each zone.

All necessary logistics, including elephants for rhino tracking and field surveys, were provided by King Mahendra Trust for Nature Conservation/Nepal Terai Ecology Project throughout the study period.

One experienced and knowledgeable local field assistant was employed for interviewing and communication with local people. Field assistants dealing with related issues during the last 12 years in the Nepal Terai Ecology Project were helping during night for monitering rhinos. Type of work and different methods were discussed with them in detail before starting the field data collection. Interview questionnaires were distributed to the local farmers in different zones prior to interviewing date to minimize hesitation and shyness with informants. Undoubtedly this also helped to minimize errors. Due to heterogenuity concerning type of data, various data collection techniques had to be employed.

The majority of farmers were very co-operative during the field survey and measurement of damaged areas, and some assisted in measuring damaged areas when the same work had to be done in different localities the same day.

Some of the relevant data was collected from Park head

quarters, the Village Panchayat Office and the Land Tax Office in Bharatpur.

3.2 Assessment of rhino density

Number of rhinos involved in crop damage was estimated on the basis of personal communication with KMTNC/SINNTEP staff, previous census records, radio telemetry work and personal experience. The local population has been cencused recently by an ongoing Terai ecology project and data was made available from that study (Dienerstein pers. comm). Most of the rhinos were identified by being marked and named previously. Having relatively small home ranges (Anon. 1987) it was not difficult to recognize them in this particular area. During "morning track follow-up" (see 3.3.2) of rhinos entering the field, minimum numbers could be reliably estimated. Rhino movement was very common in Bodreni forest. Only a few animals were resident there due to human encroachment. Rhinos from Tikauli forest and from across the Rapti river frequently moved into this area, making estimation of rhino number in that area more difficult.

3.3 Crop damage

Quantification of crop damage was made by a variety of techniques. Interviewing local farmers, park authority and hotel owners provided supplementary information to the different methods used. Economic loss was estimated on the basis of current local market prices for the different crops (appendix 4). The

methods used for quantification were the following :

3.3.1 Division of study area into different zones

The cultivated area was divided into three zones in different distances from the park boundary. Each zone was approximately 0.5 km. wide, the first lying next to the park (Fig. 2) and included about 170 households. The II zone had about the same size and households, while zone III was somewhat larger in area with more than 250 households.

3.3.2 Night tracking and morning follow-up methods

Four rhinos equipped with radio collars were chosen for night tracking to see how often rhinos entered the agriculture field and to identify damaged areas. Rhinos with frequency number .470 (female with calf), .964 (adult female), .774 (adult male) were permanently residing in Icharni Island and nearby grasslands throughout the study period. Rhino number .142 (female with calf) was resident in a forest patch across Rapti River and nearby grasslands. These rhinos were followed by elephants. Tracking was mainly carried out during night for four months during the monsoon (July to mid October), starting from the forest edges in the evening and continuing from the time they entered the fields until they came back to the park forest in the morning. Aerial photography and transparencies were used to find the location of entering points and damaged areas. Frequent following of rhinos in the agricultural field by elephant brought out some problems

and had to be discontinued. Farmers complained about the trampling damage made by the elephants during tracking, and some of the farmers even blamed us for pushing the rhinos into the fields by using elephants for research purposes. Also, some rhinos did not enter to graze freely in the field if followed by elephants. Radio tracking was therefore used mainly for estimating frequency of animals visiting the fields and for locating entry points.

A second method was therefore developed to identify areas actually damaged. The field boundary was surveyed every morning (mid August-mid February, approximately 160 days) to find the tracks of entering rhinos. The track was then followed through the fields until it turned back to forest. The damaged areas along the tracks were identified and marked for measurement. Foot prints at the entering points were erased to avoid double counts the following morning. In some cases, farmers themselves informed about damage made the preceding night. Some of the farmers hesitated to let us measure the damaged area. They thought the remaining crops and plant residues would be taken by ourselves. These kinds of problems were solved by using local field assistants.

3.3.3 Measurement and quantification of crop damage

Rice:

Extent of damage in rice fields was measured as follows

(Fig. 4):

i) damaged plots were outlined and marked with ropes and ribbon flags

ii) the damaged plots were then subdivided by parallel transects with the help of ropes and straight bamboo sticks.

iii) the following formula was used to measure the size of damaged area:

$A = \sum L \times d.$

where A = area of damaged irregular plot

L = length of transects

d = distance between transects

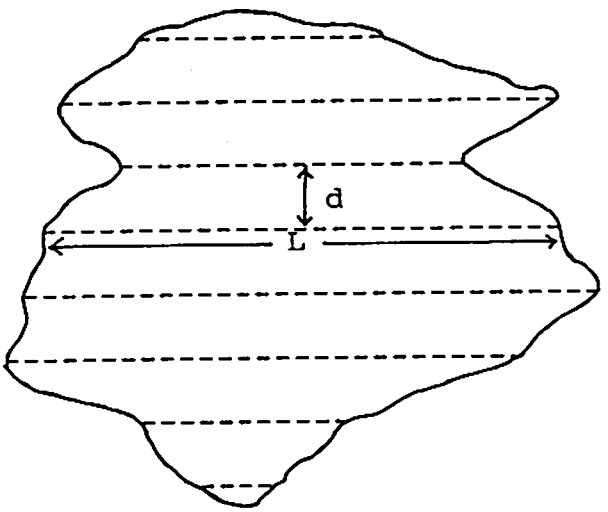


Fig. 4

At harvesting time, 3-5 control plots (N=820), each measuring 2 X 2 m were laid out randomly around the damaged plots (N=506) in a distance of 2-5 m. The crop was harvested at maturity. Yields from both damaged plots and control plots were sundried and weighed to determine the percentage lost due to

damage. The percentage lost by damage was measured in three different growing stages - Early green stage, Flowering/Early mature stage and Mature stage. Local techniques were used to harvest, winnowing and drying. The yield was measured in local units. Grains and crop residues were given back to the farmers after the work was finished.

Maize:

The main season for maize was almost finished when the work started. The quantification of maize damage was therfore made mainly by a questionnaire survey. A set of questions (Appendix 6) was asked to experienced farmers (N=105) to estimate the proportion lost by rhino damage. Some of the damaged fields were also measured and compared with the questionnaire survey. Being tall and mixed with other crops, measuring was more difficult in maize fields compared to rice crops.

Mustard:

Among the crops grown in Sauraha area, mustard was found to be little preferred by rhinos. Damage was mainly by trampling. The area damaged by trampling was estimated in three different stages of the growing period - early green stage, flowering stage and mature stage. Total area damaged by trampling was measured by counting the total number of tracks (N=306) and measuring the distance of tracks travelled by each individual animal. A strip 0.5 m wide along the central track was considered damaged area.

The tracks were categorized into three sub-types on the basis of time used: one time, two times and more than three (Table 2).

Table 2. Estimated Percent damage caused by rhinos in mustard field at different seasons and frequency of tracks used.

	1 time	2 times	> 3 times
Early green stage	10	40	100
Flowering stage	15	70	100
Mature stage	10	30	>80

(Percentages derived from field reconnaissance and questionnaires to villagers)

Damaged areas at the main entering points (used several times, (N=33) were measured with the same formula as applied for rice. Visual estimation and questionnaires were compared to estimate the total loss by trampling.

Lentils:

The extent of lentil damage was made by a questionnaire survey with farmers (N=105) in the three different zones (Appendix 6). The questions were asked only to those farmers who grew lentils at the time of this study.

Kitchen garden plants:

Damaged kitchen gardens (N=131) were sub-divided into two subtypes - partially damaged and completly damaged - to estimate

total losses. Similarly, garden plants were recorded as undamaged, partially damaged and completely damaged. Counts were made with the help of a physical counter when inspecting the gardens.

3.4 Methods to Remedy Damage

A set of questions was developed for interviewing experienced local farmers from different zones, hotel owners, naturalists, park authorities and army officers to assess the effectiveness of different methods used locally to remedy crop damage. Questionnaire forms (N=105) were distributed for comment (Appendix 5). The park boundary was also surveyed together with KMTNC/SINNTEP staff and experienced local farmers from different villages to evaluate the techniques currently in use.

3.5 Local Harassment

Another serious problem experienced by the local people as well as visitors to the park, is fear of rhinos. Quite a number of people are chased, attacked and even killed by rhinoceros every year. This problem was assessed by a questionnaire survey to both local people and tourists (Appendix 7).

The heads of the households (N=105) were asked a set of questions to determine incidence of injury/attacks and actual kills by rhinos. Some of the attacked and injured persons were also asked to comment on how rhinos reacted during attacks and their agressive behaviour.

Similarly, questionnaires were distributed to tourists (N=125) to find out which factors cause rhino attacks (Appendix 7). Some of the tourists (N=13) were also interviewed individually about their knowledge about the animal, problems of harassment and response of the government if they had been injured, and possible remedies.

Some of the tourist guides (N=7) were interviewed about their experience and means of protection against rhino attacks.

A set of questions were also designed to find out the reaction of rhinos to the colours of clothes and problem of moving around the villages during night. These questions were interviewed to the local people (N=105), mainly involved with forest and agricultural activities.

4. RESULTS

4.1 Number and Time of Rhinos Entering the Crop Field

Icharni Island, Dharampur, the forest patch 1 and surrounding grass lands across the Rapti river and Bodreni forest are park habitats of rhinos located close to the cultivated fields in Sauraha (Map 2). Rhino number in these habitats varied during the year. Numbers reached maximum during peak season of crops (October - January) in adjacent villages, while they lowered considerably during the hot season in April and May.

Approximately 57 rhinos (29 in Icharni, including both forest and surrounding grassland and bushy habitats, 9 in Dharampur, 11 in forest patch 1 and nearby grasslands across the river and 8 in Bodreni forest) were sheltered during the peak season around Sauraha. During the hot season the number decreased to about 24-31 animals (Dinerstein, pers. comm. 1989).

Table 3. Nocturnal feeding activity of four radiomarked rhinos during July - mid October.

Rhino no	.774 (ad.♂) N=13	.964 (ad.♀) N=9	.470 (ad.♀ +calf) N=9	.142 (♀ + calf) N=7
Activity				
In Sauraha fields	7	5	6	3
In Padampur fields	1	-	-	1
Chased from Sauraha*	2	1	1	1
Feeding in jungle	3	3	2	2
Frequency in Sauraha fields	53.8%	55.6%	66.7%	42.9%

* = attempting to enter fields
N = number of tracking nights for each individual animal.

Table 3 shows how frequently of the four radiomarked animals entered the agricultural field during the rice season. On average, the four rhinos visited the fields every other night. Provided these animals were representative of all rhinos residing next to Sauraha (57), about 30 rhinos should be involved in crop raiding every night. But the track count method (see 3.3) showed only about one fifth or a mean weekly maximum of 10 animals (November-December) inside the fields at any one time (Table 4).

Table 4. Number of rhinos entering Sauraha fields during night (August - mid February*).

	Mean number of tracks			
Weeks	1	2	3	4
Months				
August	-	-	4	3
September	5	4	6	5
October	5	6	6	7
November	7	10	9	7
December	9	7	10	8
January	7	6	7	6
February	6	4	4	-

* Data derived from track count method

Time of entering the agricultural field varied from night to night. Generally rhinos were more successful in crop raiding between 23.00 to 05.00 hours when the crop guards and people around entering areas were often asleep (Table 5).

Table 5. Time spent by four radio marked animals in the agricultural field during rice season.

	Entering $\bar{X}$ hour	Leaving $\bar{X}$ hour	$\bar{X}$ hr. spent in field
Rhino no.			
.774	23.35	03.50	03.15
.964	01.55	03.10	02.15
.470	24.00	02.35	02.35
.142	01.10	03.15	02.05

Rhinos spent about 2-4 hours grazing, sleeping and moving in the field during the rice season.

Table 6. Distance travelled by rhinos during different crop seasons.

	$\bar{X}$ in II &III m	$\bar{X}$ in I m
Rice	175.3	37.5
Maize	155.7	65.3
Lentil	1035.2	235.4
Mustard	1342.1	313.9

Table 6 shows the distance travelled by rhinos in different crop seasons. Rhinos travelled the longest distance ($\bar{X}$ maximum 1342.1 m) during the mustard season while during the rice season the distance much less (between 37.5 m to 175.3 m).

4.2 Damage to Agricultural Production

4.2.1 General

Much agricultural damage by rhinos was recorded in Sauraha and neighboring villages along the park boundary. Crop preference varied in different growing seasons, and loss varied with the distance from the park. Flowering and early maturing stages were preferred with a highest economic loss in rice crops. Damage in maize crops occurred from the seedling stage but highest damage occurred during the early maturing stage. Mustard was damaged mainly from trampling and only few plants were uprooted and chewed during the green stage. Lentils were preferred mainly during the mature stage. Damage in kitchen garden occurred after other preferred crops were harvested. Wheat was not cultivated widely, mainly due to rhino damage.

The total economic loss due to rhino damage was estimated at 172500.0 Rs. for the 1988/89 growing season in Sauraha Area (Table 7).

Table 7. Economic loss due to rhino damage to agricultural crops in Sauraha in the 1988/89 production year (in 1000 Rs.)

Zone	I	II	III	Total
Rice	46.4	1.2	0	47.6
Maize	25.8	3.1	0	28.9
Mustard	22.5	13.5	1.8	37.8
Lentil	9.6	12.0	10.2	31.8
K.garden	9.2	10.6	1.7	21.5
Minor crops*	4.9	0	0	4.9
Total	118.4	40.4	13.7	172.5

(* Minor crops: Wheat, Finger millet, Buck wheat, Mash, Soya bean, Beans, Banana, Sugarcane and Sweetpotato).

Fig. 5 shows the distribution of crop damage in different zones. High damage occurred in Zone I in maize, rice and mustard crops, while damage in lentil crops and kitchen gardens was more evenly distributed among the three zones.

Damage to rice and maize was not recorded in Zone III. Damage to minor crops were mainly found in zone I (Table 7). Damage to kitchen garden plants was almost the same in the first two zones.

Detailed information of damage to different crops is given in appendix 1. Only summary tables are presented in the body of the report.

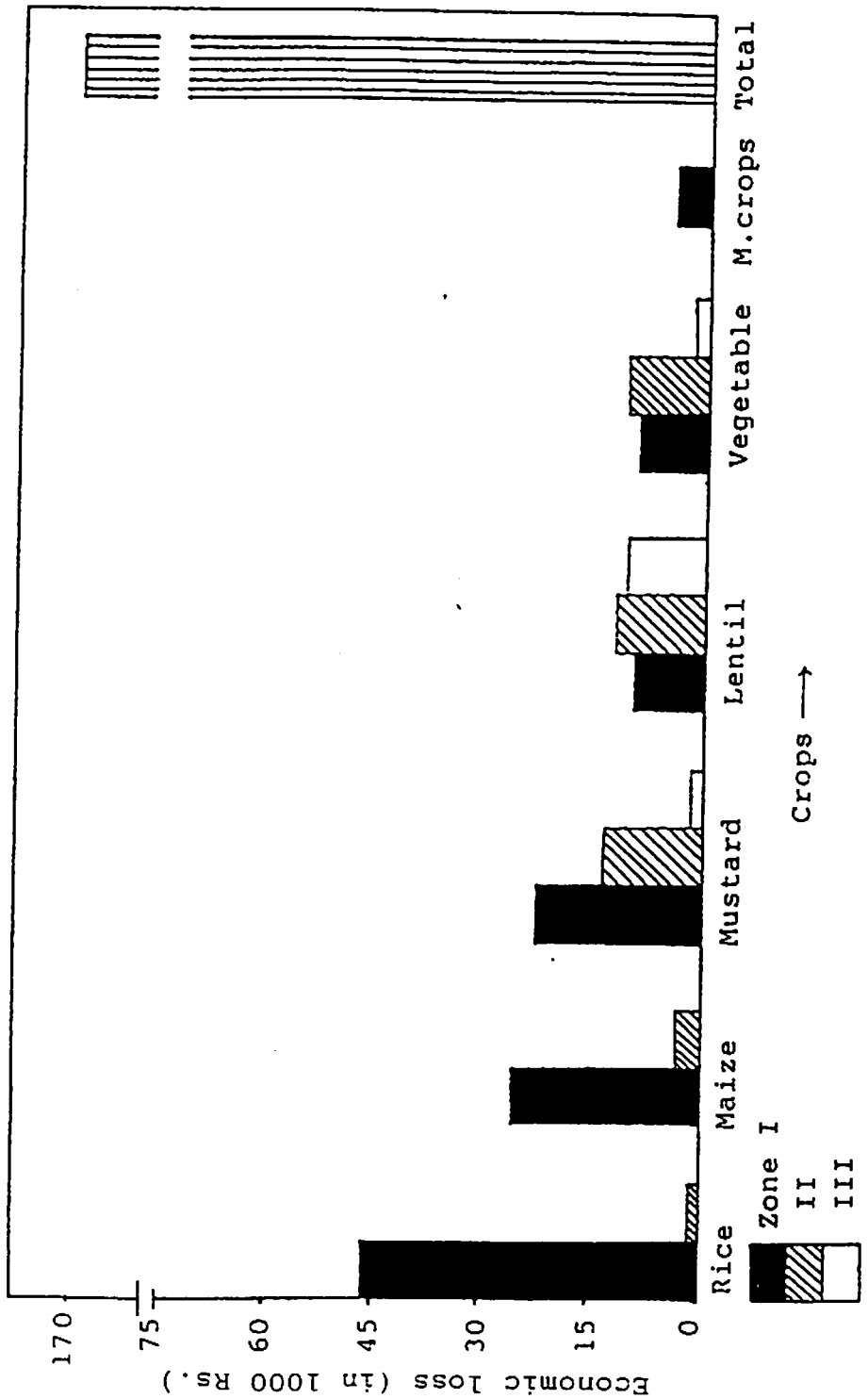


Fig. 5. Distribution of Economic Loss in Different Zones in Sauraha Area 1988/89.

4.2.2 Rice

In spite of guarding, highest economic loss occurred to rice crops in the Sauraha area. An estimated 5.1 % of the total area of rice with a loss of 11.6 tonnes occurred in zone I within a distance of 500 m of the park (Table 8).

Table 8. Distribution of area damaged and yield lost in different zones.

	% Area damaged*			Yield lost (Metric tonnes)		
Zone	I	II	III	I	II	III
Rice	5.1	0.1	-	11.6	0.3	-
Maize	1.0	0.1	-	7.6	0.9	-
Mustard	7.5	3.8	0.9	2.5	1.5	0.2
Lentil	20.8	14.2	8.5	1.6	2.0	1.8

* (of total acreage of that crop in each zone)

Only 0.1 % loss occurred in zone II. The estimated economic value, combined for both zones, was 47600 Rs (Table 7). Table 9 shows that most damage (6.4 metric tonnes) (2.4 ha) occurred in the flowering/early maturing stage in zone I. The percentage of yield lost per unit area was also highest (87% within the damaged area) in this stage (appendix 3). Zone II received a negligible loss of .1 M.t. (0.03 ha) in this stage. The early green stage, approximately 7 weeks after sowing, suffered very little damage, only 0.1 M.t. (0.4 ha), all in zone I.

Table 9. Distribution of rice damage in different growing stages in zone I and II.

	Area damaged (ha)		Total yield lost (M.t.)		Total eco. loss (in 1000 Rs.)	
Zone	I	II	I	II	I	II
Gr stg Fl/Ear.	.4	-	.1	-	.4	-
Mt stg	2.4	.03	6.4	.1	25.6	.4
Mt stg	2.1	.07	5.1	.2	20.4	.8
Total	4.9	.10	11.6	.3	46.4	1.2

In the early green stage rhinos graze as they graze in grassy meadows. Some of the plants were uprooted and also trampled. Trampling had no effect in this stage unless the plants were pushed into the soil. Significant damage of 5.1 M.t. (2.1 ha) occurred in the mature stage in zone I, equivalent to a loss of about 78% per unit area. 0.2 metric tonnes (0.07 ha) were lost in zone II in the mature stage. Only the panicles were clipped along the tracks leaving the straw untouched. No rice damage occurred in zone III.

4.2.3 Maize

Damage to maize fields occurred within a distance of 1 km from park boundary - both in zone I and II. The damage started in the seedling stage, but the main damage was recorded during the fruiting period. Table 8 shows a loss of 7.6 M.t. of maize in zone I and .9 M.t. in zone II, estimated at 25800 and 3100 Rs, respectively (Table 7).

4.2.4 Mustard

Trampling damage to mustard crops was high in all three zones - 7.5 % of the crop area in I, 3.8 % in II and 0.9 % in zone III (Table 8). Rhinos moved more widely through mustard fields seeking kitchen gardens plants and other nursery plants. Three times rhinos were recorded travelling a distance of about 5 Km during one night seeking kitchen gardens and causing considerable damage also to mustard. Trampling resulted in a total loss of Rs. 22500 (2.5 M.t.) in zone I, Rs. 13500 (1.5 M.t.) in zone II and Rs. 1800 (0.2 M.t.) in III, combined for all three different growing stages (Table 8). Of the total tracks in mustard fields, 89 % were used only 1 time, 9 % 2 times and 2 % were used more than 3 times (Table 10). Total distance walked and area damaged due to trampling in mustard field are shown in Table 10 below:

Table 10. Distribution of damage in mustard fields

	No.of tracks			Distance of track Km			Area damaged ha			
	sing	doub	>3	sing	doub	>3	sing	doub	>3	Sum
Gr stg	109	10	2	188.2	14.2	.9	9.4	.7	.1	10.2
Fl/Er Mt stg	96	13	4	147.0	18.1	5.9	7.4	1.0	.3	8.7
Mt stg	67	4	1	106.5	6.5	.9	5.3	.3	.1	5.7

Actual area damaged in all three stages was about 24.6 ha (Table 10). However, because trampling in the green stage does not lead to much loss (Table 2), most of the yield and economic loss occurred during flowering/early maturing stages.

4.2.5 Lentils

Among the farmers growing lentils, 20.8 % (1.6 M.t.) of the total area of this crop in zone I, 14.2 % (2.0 M.t.) in II and 8.5 % (1.8 M.t.) in III suffered damage (Table 8) with an economic loss estimated at 9600, 12000 and 10200, respectively (Table 7).

4.2.6 Kitchen gardens

Extensive damage occurred in kitchen gardens. Percent damage of different vegetables is shown in Table 11 (see also appendix 3).

Table 11. Losses due to rhinos in kitchen gardens* in different zones

	% plants total dam.			% plants partial dam.			Est.eco. loss** in 1000			Sum
Zones	I	II	III	I	II	III	I	II	III	
Plants										
Potato	40.4	48.5	14.5	23.8	32.8	43.2	2.2	2.0	0.5	4.7
Radish	43.4	56.0	42.9	31.4	23.2	10.5	1.4	1.7	0.1	3.2
B. Leaf Mustard	16.6	51.4	58.7	14.9	36.1	10.6	0.7	1.0	0.3	2.0
Red pepper	47.4	50.8	16.4	5.6	24.9	9.0	1.4	0.9	0.1	2.4
Cauli-flower	31.4	36.7	66.5	13.8	12.2	30.4	2.0	2.1	0.3	4.4
Egg plant	40.8	40.9	4.8	21.7	6.6	3.2	1.0	2.0	0.1	3.1
Cabbage	44.4	41.5	-	8.3	0.8	-	0.4	0.6	-	1.0
Other***							0.3	0.4	-	0.7
Total							9.4	10.7	1.4	21.5

* Among kitchen gardens which received damage.
** Estimated on basis of average local market price.
*** Bakaula simi, Tomato, Carrot and trampled onions and garlics.

Highest damage in kitchen gardens occurred in zone II. Among the damaged gardens, 48.5% potato, 56.0% radish, 50.8% red pepper and 36.7% cauliflower damage occurred in this zone (Table 11). Among the vegetables, radish, popato, red pepper, cabbage and egg plants were most severely damaged. Damage to potato started in the early green stage. Plants were then clipped and mostly uprooted. Radish was damaged mainly by uprooting and trampling. Red pepper was the most preferred plant in kitchen garden and only few plants were planted near the house and protected well. Highest economic loss (4700 Rs), combined for all three zones, was due to potato damage (Table 11). The total economic loss in kitchen gardens was estimated at 21500 Rs. (Table 11). Tomato and spices, such as onion, garlic, zinger and coriander, were mainly damaged by trampling.

4.2.7 Loss to individual households

The percent of households who suffered damage was highest in zone I in all crop seasons; rice 35.2%, maize 40%, lentil 24.7% and kitchen gardens 34.8%. The percentage decreased sharply as the distance increased to zone II: rice 0.1%, maize 5.7%, lentil 20.0% and kitchen garden 22.0%, with further decrease in zone III, except for lentils and kitchen garden plants (Table 12).

Table 12. Distribution of losses among farmers in different zones (mustard and minor crops excluded because damage was widely distributed). Coefficient of variation in parenthesis.

	% farmer with loss*			Estimated loss/Hh (1000 Rs)**		
Zone	I	II	III	I	II	III
Crop						
Rice	35.2	0.1	-	0.83 (72)	0.50 (103)	-
Maize	40.0	5.7	-	0.41 (33)	0.26 (9)	-
Lentil	24.7	20.0	8.5	0.53 (48)	0.63 (63)	0.68 (43)
K.plants	34.8	21.1	1.8	0.15 (52)	0.21 (35)	0.23 (16)

* among those farmers growing that crop
** estimated on basis of average local market price

Highest economic loss per household occurred in rice, maize, and lentils in zone I, with highest loss for rice ($F=4.293$, 2 df, $p<0.02$). Rice loss was less (500 Rs./household, $t=2.304$, $p<0.02$, 56 df) but few farmers were affected there. Total number of households who suffered damage was high in the flowering/early mature stage (44) and highest economic loss (Rs. 581.8/HH in zone I) occurred at that stage (Table 13). Only 26 households suffered damage in the green stage with negligible loss at that time.

Table 13. Distribution of rice damge among households.

	No of Hh with damaged		$\bar{X}$ Yield loss/Hh (Metric tonnes)		Eco Loss/Hh (Rs.)	
	I	II	I	II	I	II
Gr. stg.	26	-	.004	-	14.6	-
Fl/Er M. stg	44	2	.146	.02	581.8	190
Mat. stg.	43	1	.119	.20	474.4	760

Maize loss was restricted to the first two zones with an

economic value of Rs. 410/household in zone I and Rs. 260/household in zone II (Table 12). Economic loss per household due to damage in lentil crops was equal in all three zones (F=0.0287, 2 df, ns) but the tendency was for higher damage to households further away from the park (680 Rs./household in zone III).

34.8 % of the households in zone I, 21.1% in II and 1.8 % in III suffered damage in kitchen garden (Table 12). The economic value of the damage in kitchen garden plants was estimated on the basis of average local market price for all plants. Estimated economic loss among damaged kitchen gardens was more or less evenly distributed in all three zones. The highest mean loss, Rs. 230/household, occurred in zone III (Table 12).

4.3 Traditional means to remedy the problem of crop damage

Quite a number of different methods are applied to reduce rhino damage. Machan/house guarding, Mukka, Trench and Fence are the most commonly used methods in Sauraha and adjacent villages (Table 14).

Table 14. Means applied to reduce damage for different crops

Means	Maize	Rice	Mustard	Lentil	K. garden
Machan/ house guard	x	x	-	x	x
Mukka	x	x	-	x	x
Hanging coil	-	-	-	-	x
Tin bell	-	x	x	-	x
Ghuentro	-	x	-	x	x
Plastic flag	-	x	x	-	x
Trench	x	x	x	x	-
Fence	x	x	x	x	x

(x indicates the methods applied to reduce individual crops)

These methods are briefly described below:

4.3.1 Machan

A small cottage (platform with roof), locally known as Machan, shedded with thatch grass, is erected prior to the maturity of the crop for guarding purposes. The roof, and the platform underneath, is supported by tree trunks. The platform is mainly made of planks or straight tree trunks to lay on while guarding. The bed is made uncomfortable to avoid sleep. Machans are established at rhino entering points and inside the field of the maturing crop. A total of 85 machans were recorded during the rice season in zone I along the park boundary, mostly one per household depending on the length of the field along the boundary. Various types of scaring devices are used during guarding from machans (see: 4.3.2.). Guarding starts from about 08.00 in the evening to about 06.00 hours in the morning every night for rice (end of August - November), maize (May - June) and lentil (March). In most cases, adult middle-aged men (26-40 years, $\bar{X}$=33 years, 61%) do the guarding. Women and children never guard as it is too risky for them. Guarding is also made from the house if the cultivated crops are very close to it. Machans are used for all crops except mustard (Table 14).

4.3.2 Scaring devices

Various types of scaring devices are used to chase animals away from the field. "Mukka", a bundle of burning thatch grass,

canes or straw, is the most widely applied scaring device in the area. Quite a number of such bundles are stored in the machan and used whenever needed. A burning coil of straw was also recorded hanging from poles or fences, used for scaring rhinos mainly in kitchen gardens.

A traditional tin bell, placed in the middle of the maturing field, is another common device used by local people in Chitawan. A tin plate, supported by two wooden poles, is hit by a thick and heavy wooden piece. The whole system is operated by the guards from the machan with the help of a rope. Tin bells are moved according to the probability of getting damage. This scaring device is mostly fixed in the middle of the maturing field. Tin bells are also used to scare birds during daytime. This device is used for all crops except lentil.

Use of "Ghuentro", one of the most traditonal techniques, was recorded mainly by the ethnic Tharu people. An about 2.5 - 3 ft. long rope is used to throw gravel at rhinos and is used only during short crop seasons against damage to rice, lentil and kitchen gardens.

Making loud voice, hitting small tin boxes, producing sounds by shaking plastics and throwing dusts and stones and even hitting rhinos on the rump and feet are among other means used to scare animals in Sauraha.

4.3.3 Trenches

Deep long trenches, about 1 - 1.5 m deep, are common along the park boundary, dug by local people to stop the rhinos from entering the field. They are cleaned every year after the monsoon. Some farmers plant shrub species on the edge of the trench towards the field. According to the local farmers, such shrubs hide the trenches and confuse the animals. Trenches east of Harnari were covered with Dhursia Calbrookia oppositifolia shrubs, while trenches in Bagmara area were covered mainly with Besarma. Roots of these plants help reduce erosion during the monsoon.

Besides this, some shorter trenches are dug perpendicular along the long trenches in some areas. A row of such perpendicular trenches, about 1 m deep and 1.5 m long, together with long trenches were very common in Harnari, Gauhi and Bagmara.

A third type of trench practiced by the farmers in the eastern areas was a set of both long and perpendicular trenches. Perpendicular trenches were dug between two long trenches. The long trench on the field side was mostly deeper than the outer one. Some farmers had also built fences together with the set of these trenches.

4.3.4 Fences

Various types of fences have been erected by local farmers along the field boundary and around the kitchen gardens. Bayar Zigiphus mauritiana, a thorny shrub species, and canes of tall

grasses are commonly used as fence materials.

In some villages, farmers also used living fences together with long trenches. About 1 m thick and 2.5 m tall fence of thorny Euphorbia species in Malpur village is an example of such a living fence. Ansuro and Dhursia are other common species used as living fence material in Sauraha. A fence, knitted with canes of tall grass, mainly Phank Norenga porphyracorma, is commonly used to protect kitchen gardens by Tharu people. Tagaro, a common wooden gate, is often erected outside the house compound to stop both wildlife and livestock from entering the field behind the house. Such gates were also erected at the main entering points of the main roads to the village along the boundary, mostly around Gauhi area. During night, plastic pieces are hung on it to scare wild animals, mainly rhinos. Similarly, quite a number of plastic flags were also fixed in the fields mainly to protect rice, mustard and kitchen gardens.

4.4. Assessment of effectiveness of traditional means applied in Sauraha Area

Guarding, together with scaring devices (mukka, tin bell and plastic flags) was found most effective in rice, lentil and kitchen gardens, probably due to short vegetation type where the animals could be seen (Table 15). Ghuentro can also be an effective means in these cases during moonlit nights for short distances.

Table 15. Effectiveness of traditional means. Rating between 3.0 (best) to 0.1 (very little effective).

Means	Maize	Rice	Mustard	Lentil	Kitchen garden
Machan/house guarding	2.0	2.7	-	2.6	2.7
Mukka	1.3	2.8	-	2.7	2.8
Hanging coil	-	-	-	-	1.6
Tin bell	-	.8	.7	-	1.4
Ghuentro	-	1.2	-	1.3	1.6
Plastic flag	-	.3	.1	-	1.1
Trench	2.3	2.7	2.6	2.6	-
Fence	.2	.1	.6	.1	1.3

(Grading is made on the basis of a questionnaire survey (N=105) and communication with local, experienced personnel)

In tall maize fields animals are detected only by the sound produced while walking or chewing the plants or cobs. Only mukka had some effect in this crop. Tin bells and plastic pieces have a little effect in maize fields due to dense and tall vegetation, and ghuentro can not be used in such fields. Hanging coil (see 4.3.2) was found effective only in kitchen gardens during winter since it requires dry weather. Entering points with hanging burning coils were rarely used repeatedly. Hitting rhinos, although it is very risky, is an effective means, mainly in short crop fields and during moonlit nights where animals are clearly seen. Rhinos hit once on the rump or feet never attempted to come back at least for 15 days (Girdhari pers. comm.).

Deeper (2.5 to 3 m), narrow and steepsided, long trenches in combination with short, narrow and about 1.5 m deep perpendicular trenches were most effective to keep rhinos out of the fields throughout the year. Less deep trenches with no drainage in loose sandy soil were ineffective, as they filled with rain

and often eroded. In such cases rhinos easily press down the soil and cross. Plants on the edges of trenches reduce slope erosion and less cleaning is required. Trenches along the river bank facilitate erosion during the monsoon.

Fences are made of very poor fence materials in Sauraha. Rhinos easily destroy them by the snout or push them down by the rump. A fence close to the machan is effective because it produces sound while being broken by entering animals and therefore alerts the nearby guard. Knitted fences, supported by thick wooden poles and hung with plastic pieces around the kitchen gardens are rather effective as the animals are scared by such devices. They also produce sound while being broken which alerts the house guards. Habitually rhinos walk carefully without producing any kind of sound while seeking safe entering points. A living Euphorbia fence is a most effective fence as the plants bear long, fine and sharp thorns all over the trunk making a thick and tall impenetrable barrier. Other shrubs planted on the trench edges make animals confused about the location and the depth of the trench.

4.5 Accidents and harassment to human life

4.5.1. Local people

Data collected for the years 1978 - 88 showed a total of 78 accidents - 23 kills and 55 injuries - among local people (15.4 % Brahmin, 46.2 % Hill Matawali and 38.5 % Tharus) (Table 16).

Table 16. Distribution of number of people killed or injured, 1978-88.

Year	78	79	80	81	82	83	84	85	86	87	88	sum
Killed	3	2	3	4	3	2	1	2	2	1	0	23
Injured	6	5	3	7	3	7	3	5	6	5	5	55

Most of the accidents (57.7 %) occurred outside the park while grazing cattle, collecting fuelwood/fodder and fence materials, walking around in the villages in the evening, collecting snails and fishing in nearby rivers and local bush toilets. 32 % was recorded from the agricultural field while guarding crops, and 10.3 % of the accidents occurred inside the park during thatch grass cutting and illegal activities in the park (Table 17).

Table 17. Distribution of ethnicity, location and activities among accidents to local people in Sauraha.

	Ethnicity			Location			Activities				
	B	HM	T	Pout	Pin	Ag	Cffg	Ctch	Bto	Aga	Other
Kill	5	9	9	15	2	6	10	2	2	4	5
Injured	7	27	21	30	6	19	21	3	3	17	11

B = brahmin, HM = hill matawali, T = tharu, Pout = park outside, Pin = park inside, Ag = agricultural field, Cffg = collecting fuel/fodder and grazing cattle, Ctch = collecting thatch grass inside the park, Bto = bush toilet, Aga = Agricultural activities and chasing rhinos from field.

Among the sexes, 70.5 % were males and 29.5 % females (Table 18). Table 18 shows the age classes of the victims. A high frequency of accidents (39.7 %) occurred among middle aged

people between 26 -45 years. Similarly, the data on physical condition among the victims showed that 75.6 % were in normal physical condition, 2.6 % sick and physically weak, 6.4 % deaf and 5.1 % were alcohol users (Table 18).

Table 18. Distribution of age, sex and condition among people killed and injured.

	Age				Sex		Condition				
	5-25	26-45	46-65	>66	M	F	N	S	Df	Vo	Dk
Kill	4	7	9	2	15	8	17	-	2	2	2
Injured	17	24	11	5	40	15	42	2	3	6	2
Total	21	31	20	7	55	23	59	2	5	8	4

(Condition: N = better, S = sick, Df = deaf Vo = very old, Dk = drunk.)

4.5.2 Tourists

Data on accidents among tourists were available only for a short period. Table 19 shows the sexual distribution among 14 accidents for the year 1984 -1988 (56.3 % males and 43.7 females).

Table 19. Distribution of accidents among tourists.

Year	1984		85		86		87		88	
Sex	M	F	M	F	M	F	M	F	M	F
Kill	-	-	-	-	-	-	-	-	-	-
Injured	3	-	-	2	2	1	2	-	1	2

4.6. Means to protect from rhino attacks

A few traditional techniques have been applied to escape from rhino attacks by local people and visitors to the park. They are described briefly below:

4.6.1 Tree support

This is the most common method used by local people. This can be used by two ways. Firstly, an easy and strong enough tree is climbed as soon as a rhino approaches. Secondly, one thick or more trees growing very closely are circled making loud noise until the animal goes away.

4.6.2 Leaving goods behind

In this method, a piece of cloth or any goods is thrown behind while running away. Rhinos tend to stop and attack material left behind. This method of escaping from rhinos is frequently used by local people as well as the visitors to the park.

4.6.3 Mukka (Fire stick)

Mukka (See: 4.3) is a widely used and most effective device during night. It is the only means which can be used at night while moving from one village to another.

4.6.4 Sinking into water

Another effective means used by ethnic Tharu people is to

jump into water and swim or crawl ahead if the attack occurs near water. This escape method can not be practiced in the monsoon when the river is flooded and rapid.

4.6.5 Running through trenches

Running through deep trenches or jumping up and down from high edges is another common method used in agricultural field.

5.7. Effectiveness of traditional means against rhino attacks

Table 20 shows the effectiveness of different locally applied protective means against rhino attack. Climbing or encircling trees was found much more effective in the riverine forest where trees are branched and easy to climb (such as veller, Kutmiro, Sindure, Ginari etc.) and thick enough (Simal) to encircle than in pure Sal forests.

Table 20 Effectiveness of means in different habitats

Means	Forest	Grassland and bush	Open areas		Agri		Water
			day	night	day	night	
Tree support	2.7	-	-	-	-	-	-
Goods behind	1.7	1.9	2.5	1.7	-	.3	1.6
Mukka	2.7	2.7	-	2.8	-	2.8	-
Sinking	-	-	-	-	-	-	2.7
Trench run	-	-	-	-	-	2.3	-
Crawling	1.8	2.6	-	-	-	1.9	2.6

A questionnaire survey made to find out the reaction of rhinos to the colour showed that white (49%) and red (42%) colours were the most risky in both in forests and agricultural fields.

5. DISCUSSION

5.1 Extent of Crop Damage

In spite of extensive guarding, total damage to agricultural crops in the different zones from the park showed a heavy loss of Rs. 172500 for the 1988-89 production year. A similar study to assess the damage by wildlife in nearby Padampur area across Rapti river from Sauraha was conducted in 1977 by Milton and Benny (1980). They estimated the mean loss to be 55.8% of all crops grown in that area, while the loss was only 6.6% in Sauraha. Milton and Benny equated the economic loss to 24460 Rupees in Padampur which is only about 1/8 of that recorded in Sauraha in this study. The low economic loss estimated for Padampur was probably due to the methods they applied, as the study was mainly based on a questionnaire survey with no quantitative measurements of actual damage. Other factors for their lower estimate might have been the size of the area, and the time, as their study was conducted 12 years ago with lower market prices for crops in those years.

The extent of crop damage in Sauraha area varied with the distance of the agricultural fields from the park boundary and the location of the field crops. Among the zones, zone I was severely attacked with a highest economic loss of 68.6%. Similarly, cultivated fields located close to the park forest repeatedly received damage during all crop seasons (such as Bagmara, Laukhane, Jankauli and Harnari areas).

Among the crops grown in Sauraha, highest economic loss (27.6%) occurred to rice crops, mainly limited near the park boundary in zone I. From the tracking data it was found that rhinos detected in zone I were usually chased back to the park. Undetected rhinos grazed only in zone I and the noise produced to chase rhinos in that zone helped guards in zone II to be successful in not letting rhinos enter their fields. Rice received highest damage (54.6%) in the flowering and early maturing stage. During this stage big feeding patches of up 387.33 sq m were recorded from the Bagmara, Jankauli and Harnari areas. Negligible loss occurred in the green stage because rhinos then (July-August) spent most of the time in the park feeding on favoured grass species, especially kans (Saccrahum spontanum) and fruits of Veller (Trewia nudiflora) as they are abundant in the park (Laurie 1979, Dinerstein and Wemmer 1988, Gyawali 1986). As the rice crops become coarse, damage occurred only in small patches. Rhinos only clipped panicles leaving the straw untouched in this stage. Coarse rice varieties such as Pakhe Mansuli were not preferred and less damage occurred in fields planted with these varieties during the mature stage.

Second highest (21.9%) economic loss occurred to mustard crops. After the rice is harvested, most farmers stop guarding along the boundary, and existing barriers, such as trenches and fences, are rarely maintained. This allows rhinos to move frequently into agricultural fields seeking other food crops. As a result, mustard and kitchen garden plants were mainly damaged

after the rice was harvested. Damage to mustard was mainly due to trampling during flowering/early maturing stage. Mustard plants were occasionally clipped and eaten during green stage and mature stage while eating Gainda Kara Cirsium wallachii and Bethe Chinopodium spp., the two most preferred herb species growing together with mustard (pers. obs.). The loss was distributed in all three zones, but with highest economic loss (59.5%) in zone I. The area damaged to mustard crop is higher than rice but with lower economic loss. This is because the effect of trampling during the green and mature stage is very low, 10%.

Third highest (18.4%) economic loss was due to damage to lentils. Damage to lentils was more evenly distributed in all three zones with the highest (37.7%) in the second zone from the park. During early hot season (late February - April), rhinos feeding on lentils in this zone were mainly recruited from Icharni and Bodreni forests. Most of the rhinos which were chased from zone I attacked crops in the other two zones as there were no guarding or any other protective measures at that time. Contrary to other crops, lentils were mainly eaten in the mature stage. Lentil was most heavily damaged in relation to area grown of that crops. Only 30% of the total number of farmers grew lentils, as it is severly attacked.

Damage to maize (16.8% of total) was highest during the early maturing period (April-May). The loss decreased with increasing distance from the park, but maize in zone II received

relatively higher economic loss than rice crops. Detecting entering animals in maturing maize fields was difficult compared to short crops such as rice and lentils. Both undetected and chased rhinos from I zone were more successful in entering zone II due to the tall vegetation provided by maize.

Rhinos rarely entered the agricultural fields during daytime. Laurie (1979) only recorded one rhino in the maize fields near Sauraha during daytime, and only two animals, both in maize fields, were seen during daytime in Gauhi area during this study.

Damage to kitchen gardens was severe during December and early February when other preferable crops were not available. Economically, the loss (12.5% of total) was almost as high as that of lentils. Damage was almost equally distributed in the first two zones with only a few gardens damaged in zone III. As for lentils, kitchen gardens in zone II were heavily attacked by rhinos from both Icharni and Bodreni forests. Malpur, Botegaun, east of Bagmara and Jankauli villages were among the most severely attacked during the vegetable season in zone II. House guarding and hanging coil were most common in kitchen gardens. Among the vegetables, red pepper was most preferred, and - therefore not much cultivated, while spice plants and tomato plants were untouched. Highest economic loss in kitchen gardens was due to potato (21.9%), cauliflower (20.5%), radish (14.9%) and egg plant (14.4%).

Due to severe attacks to wheat crops, farmers in Sauraha have almost completely stopped growing that crop plant. Only 7 farmers in Gauhi area cultivated wheat in the 1989 production year. Similarly, Finger millet and Buckwheat were not widely grown, the latter being attacked much by vermin pest.

The cropping system in Sauraha is mixed, both for subsistence and cash crops. Farmers grow almost all crops in different seasons. Those farmers who got damage to one crop, usually also received damage to other crops. Roughly about 1/3 of the households, or about 100 households all together, in zones I and II received rhino damage. On average, each household suffered a loss of roughly Rs. 2000/year (excluding mustard damage). That means a about 10% of their annual yield. For those farmers who own big farms, this may not be a serious problem. However, for farmers with less land, it is quite serious, as the loss is equivalent to about 6 quintols of maize which is enough to feed a family of 5 working members for 5 months, or equal to about 3 months salary for a civil worker as for instance a park game scout.

Besides this, farmers spend every night to protect the crops and they have to work the following day. Undoubtedly this has adverse effect on both health as well as on the efficiency of their work (Milton and Binney 1980). For instance, a young farmer in Harnari village was seriously sick and hospitalized, mainly because of lack of sleep, for more than 20 days after long

guarding of rice. If the farmers had alternatives, their time could be used more productively in other activities.

5.2. Injuries and harassment

A total number of 78 accidents occurred among local people within a short time period of 10 years (1978-88). This figure includes a few accidents in Bodreni and a neighbouring village (east of Gauhi), outside the main study area. Middle aged adult men in normal physical condition were most frequently injured and attacked by rhinos. Most accidents, about 85%, were among the Hill Matwali and Tharu people as they are most active in the agricultural fields, guarding crops, and in the forests. Nearly all accidents (90%) occurred outside the park, mainly while collecting fodder/firewood, grazing cattle or while guarding crops and chasing rhinos from field crops. After raiding crops, some rhinos spend the early morning hours sleeping in nearby bushy areas where local people go for bush toilets. About 6% of all accidents occurred early in the morning in these habitats. Elderly and disabled people were not especially prone to attacks, as they were less active in both field and forest activities.

It is always risky to move around in the villages at night as the probability of meeting rhinos is very high. Therefore, local people do not move frequently after 9 o'clock in the evening until it is completely light in the morning. In misty mornings rhinos stay in the fields longer before returning to the Park forests. It may cause serious accidents to local people. A

few years ago a female rhino attacked a school boy and an old farmer in nearby Sauraha at around 9 o'clock in the morning, probably because of misty weather and disturbance by local people (pers. exp.).

Besides local people, confrontation with careless tourists occurs every year (Upreti 1985), mainly due to poor knowledge about rhino behaviour and poor guiding. Most of the accidents occurred due to their own carelessness as they tried to approach rhinos closely without paying any attention to advice from their guides.

The questionnaire survey among tourists visiting RCNP showed that about 3/4 of the tourists had very poor knowledge about the animals, their behaviour and habitats. Some had a fair knowledge acquired by literature and conversation with local guides. Only 6.2% had good knowledge on wildlife. The latter included tourists with wildlife background and second time visitors.

Local guides contribute an important role while walking and approaching rhinos in the jungle. Most of the tourist guides, except those from high standard hotels, have minimum experience about the animals, their habits and their temporal and seasonal movement inside and outside the jungle.

Among the means used against rhino attacks, tree support is most widely used if the accidents occur in forest areas. However, the success of all efforts depends on various factors such as:

i) distance between rhino and victim

ii) skill to climb trees

iii) type of dress, as shoes and womens' sari makes it quite difficult to climb the tree.

Attacks varied among rhino social groups and from colour of clothing of the victims. Mother rhino with calf is the most aggressive social group (Laurie 1979). More than 50% of all accidents occurred by this group. Male rhinos were most aggressive and dangerous during fights and mating, and sub-adults are generally timid (Laurie 1982). Among colors, white and red were found most risky.

Damage to agricultural crops and harassment to the local people occurs mainly due to lack of any effective physical barrier between private/public areas and the National Park which allows rhinos to enter the fields freely. Trenches of proper size normally serve as an effective barrier to stop large animals (Schultz 1986), such as the rhinoceros, and traditional means to reduce crop damage have been applied for a long time. No improvement in these means and no new techniques have been developed to remedy the problem in recent years. Trenches in sandy soil along the river bank were poorly managed in both Harnari, Bagmara (in nearby river bank) and Jankauli areas. The existing trenches lacked enough depth and steepness, and they were poorly maintained during the monsoon. Farmers in Harnari and neighboring villages along the boundary in the east did not dig deep and

permanent trenches, as they probably intended to increase their agricultural land at the expense of park forest area.

5.3 Trend in rhino number and human conflicts

Poaching had been a significant source of mortality until the 1970's. Since the park was established, the animals have been well protected and the population has increased by an average annual rate of 3.8% since 1975 (Dinerstein and Price 1989). Density per unit area along the fringes of the park fluctuated seasonally with the ripening of rice, corn and lentils grown in the adjacent fields. During the maturing of rice in 1987 (October-December), the density in Bodreni and Dharampur area was estimated at 8.3/km, declining to 3.0/km by February 1988 after the beginning of grass fires in the park (Dinerstein and Price 1989). This is a very high density for such a large herbivore as the rhinoceros.

Rhinos around Sauraha are habituated and not shy to humans because almost all rhinos in these habitats are frequently approached and disturbed by grass cutters, elephant drivers and tourists on both elephant and foot. Consequently, most of the animals do not hesitate to enter the fields during the night. Furthermore, the park habitats along the boundary adjacent to the villages are overutilized and heavily degraded (Sharma 1986, Edson et al., 1988). Quite a number of elephants (about 35, both government and private) graze every day inside the park within 1-

3 km of the village, and grasses, mainly kans, are collected from the park grasslands for elephant feed. Similarly, illegal livestock grazing and both legal and illegal grass cutting inside the park have reduced the amount and quality of forage for wildlife. This has probably affected rhinos in particular, because they require large quantities of food. As a result, crop feeding has become an important supplementary diet for the growing rhinos population, especially when the grasses most favoured by rhinos are in short supply (Laurie 1973).

The grazing meadows along the forest edges are heavily grazed by livestock from the neighboring villages. More than 200 domestic stock are grazed every day in the meadows and bushy habitats between Gauhi and Hattisar (pers. obs.). The palatable grass species in the meadows are disappearing and being replaced by unpalatable herb species such as Tapre and Banmara.

Especially Bodreni forest is heavily degraded as there is no restriction on cattle grazing and collection of fodder/firewood for local people (Edson et al. 1988). Similarly, large grazing meadows and nearby forests in Bagmara area are seriously degraded by more than 250 livestock from surrounding villages (pers. obs.).

Simal flowers are an important supplementary diet of rhinos during winter (Gyawali 1986). This food supply is steadily becoming reduced due to pruning the branches for winter food for elephants on Icharni island and the forest patches across the

river. Other winter browse species are also in short supply. A small patch of Baramashe Coffea bengalensis, a winter food shrub, in the middle of the riverine forest on Icharni island is now depleted due to overuse. Similarly, another important winter food species, Kutmiro (a tree species) is now limited mainly around the SINTEP camp.

As a result of lack of good and enough food in the park, especially during winter (September-February), rhinos enter the fields frequently and supplement their food requirements from the agricultural fields. Tracking data showed quite a high frequency rate (57%) among rhinos entering the fields. That was probably an overestimate due to a biased sample. The four radiomarked animals residing permanently near the village were probably more habituated and specialized on crop raiding than most other rhinos. If those four animals represented the whole population (50-60 animals), about 35 rhinos should visit the fields every night. Since the maximum number recorded by the track count method was 13, the whole population was probably split into basically "forest dwellers" and "crop raiders".

To stabilize the rhino population and avoid the risk of the population being wiped out by an epidemics, the Nepal Government has recently started to relocate animals from the park. Altogether 21 rhinos, about 27% of the local population around Sauraha, were relocated to other reserves or zoological parks during 1986-87 (Dinerstein and Price 1989). There are plans to translocate more animals in the coming years.

6. RECOMMENDATIONS

The problem of conflict of interest between rhinos and people, particularly in Sauraha area, should be solved by a combination of direct and indirect methods:

a) Direct methods

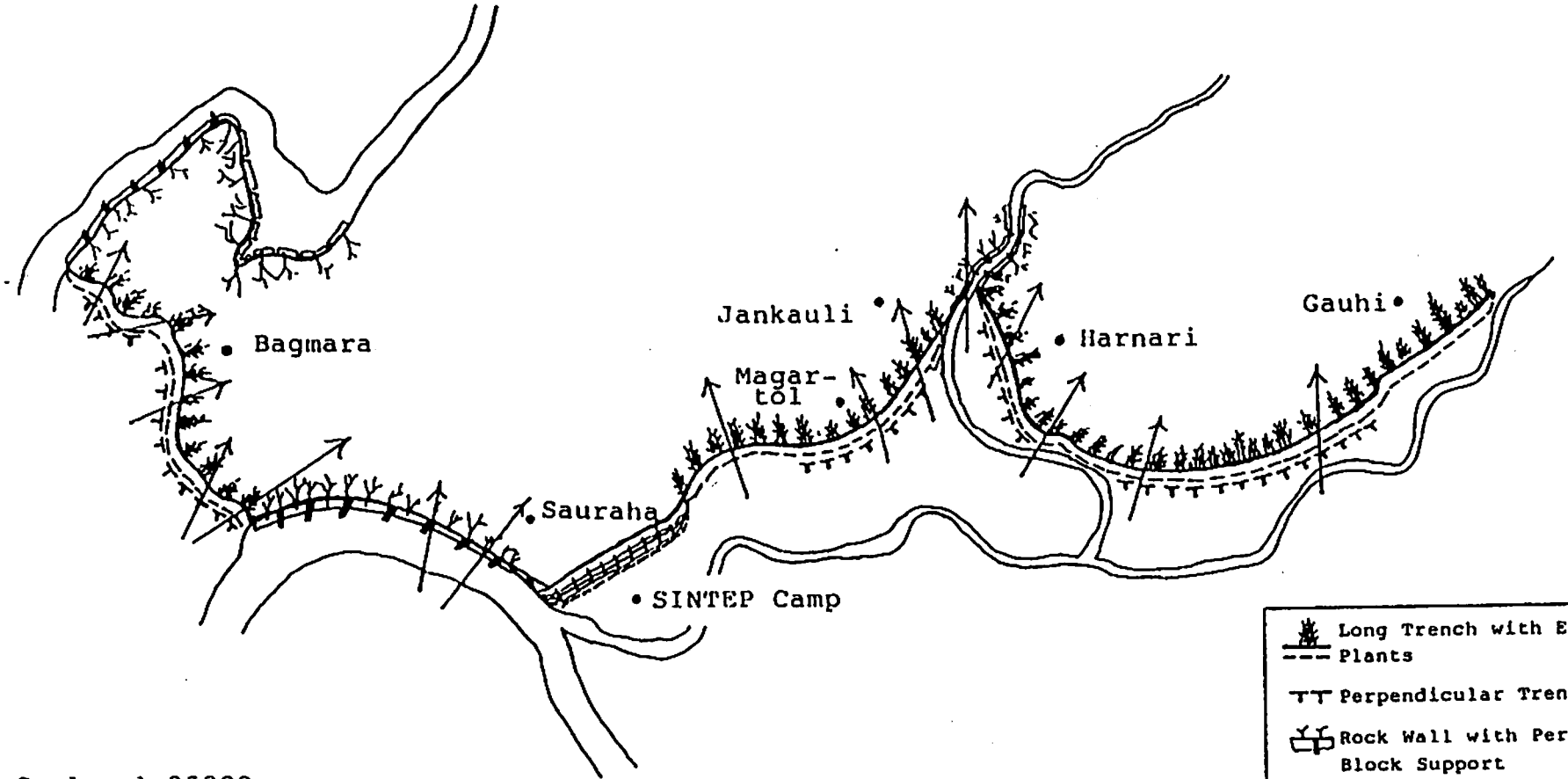
i) Physical barriers to keep animals inside the park

Lack of effective barriers between the Park and public/private land is the major cause of problems associated with crop damage in Sauraha area. The problem should be solved by fixing effective physical barriers to stop freely moving rhinos. Digging about 2.5 - 3 m deep, 1.5 m wide and steepwalled (75° steepness) trenches along the field boundary is proposed for the Sauraha area where this study was conducted (Fig. 6). In addition to this, a row of perpendicular trenches (1.5m deep and .75 m wide), 1 m apart, could be most effective where the soil type allows to dig such trenches. Euphorbia plants should be grown as a living fence on the field side of the long trenches. These combination trenches can be dug in Bagmara between Budhi Rapti and Rapti River, in Sauraha between Temple and Dhungre river covering both Magartol and Jankauli area, and in Harnari between Dhungre River and the eastern border of the study area (Gauhi village) where the soil is tough. Trench walls in sandy soil near the river banks should be stabilized with rocks in order to reduce slope erosion during the monsoon and to prevent rhinos from crawling

across. Water exit canals should be made in association with these long trenches to minimize erosion due to water filling. Heme pipes should be fixed as water outlets in those areas where water flows out from the field during the monsoon such as in Mugarbudhi in Bagmara and in east Harnari.

Trenches can not be made along the eroded Rapti and Budhi Rapti river banks and along both banks of Dhungre River due to their changing nature and heavy monsoon floods. In these cases a continuous stone block (filled in metal strings), about 3.5 m high and 2 m wide, should be erected from the river basin (Fig. 6). About 2.5 m long stone blocks could be fixed perpendicular to the continuous stone wall as a support during the rapid current of the monsoon. Farmers should also be encouraged to make plantations by providing free seedlings such as Bamboo and Sissoo and other fast growing trees on eroded slopes to stabilize the soil. Undoubtedly, this would be most effective to minimize the continuous cutoff of fertile cultivated land along the river bank in Sauraha.

An old barbed wire fence still exists as park boundary from the river bank to the Hattisar area which is almost collapsed. This allows both livestock and wildlife to move freely. Maintenance of this fence is very important in order to stop livestock from nearby villages from entering the park. In addition to this, a trench (as mentioned above) along the fence should be dug on the park side to stop rhinos and minimize the probability of the



Scale: 1:35000

Fig. 6. Map Showing Locations for Proposed Means to Remedy the Problem and Main Rhino Entering Points During Rice Season 1988.

fence being damaged by rhinos.

A strong wooden gate, locally known as Tagaro, should be erected at the entering points of the main roads along the park boundary to stop rhinos from entering through them, as in Gauhi area. Materials for such gates should be made available from Park resources.

ii) Compensation for damage

The problem of conflict interests should be reduced by compensating farmers directly in cash for their loss, or exempt them of the annual tax for cultivated land, park entry fee and fee for collecting thatch grass inside the Park. Amount of compensation should be determined by Park authorities and Panchayat officials after inspection of damaged areas.

Likewise, local farmers injured by rhino attack should be helped with medical facilities, transportation and food during medical treatment. Families whose family members are being killed by rhinos should be compensated directly in negotiable cash.

b) Indirect methods

i) Reduce human disturbance inside the park

Elephants carrying tourists approach rhinos too closely. This helps rhinos get used to people, thus facilitating problems

of both crop damage and harassment. This must be stopped by fixing certain minium distance for viewing purposes. The existing viewing towers inside the park are few in numbers and in very poor condition. The number of towers should be increased and maintained properly.

ii) Reduce habitat degradation

The problem of overgrazing and other human activities affecting flora and fauna and degrading natural rhino habitats should be strictly reduced. Elephant grazing and food (grasses and tree branches) collection for domestic elephants, mainly during winter, should be directed to those areas where rhino density is low and grasses are abundant, for instance in the Dudhaura area and further southwest.

Livestock grazing inside the park is among the most serious problems of rhino habitat degradation. This is a challenging and difficult task for park authorities to solve. Most probably it can only be done by reducing the number of livestock, mainly cows, per household by introducing better breeds of buffaloes, cows, goats and sheep, and by encouraging farmers to plant fodder trees on private lands.

Encroaching unpalatable plant species in grasslands, grazing meadows and bushy habitats should be removed annually to promote

better growth of more palatable species.

Illegally increasing of agricultural lands, mainly in Harnari area, at direct expense of park land should be stopped immediately by fixing permanent barriers.

iii) Introducing unpalatable crop varieties

Some crop varieties such as Pakhemunsuli were less preferred, probably due to their coarse nature. Such less preferred rice varieties and varieties of other less palatable crop plants should be introduced and farmers should be encouraged to cultivate them.

iv) Controlling the rhino population

Study of the carrying capacity of the park of large herbivores such as the rhinoceros, particularly in the local problem areas of Sauraha and Padampur should be made regularly by annual censuses. If the number exceeds the carrying capacity, the animals should be translocated to other reserves and zoos or should be pushed into areas of less density and more abundant food plants within the park. Translocation of rhinos from RCNP has already started. All together 21 animals (6 to Dudhuwa National Park in India, 13 to Royal Bardia National Park and 2 to other zoos) from the Sauraha area have already been moved (Mishra and Dinerstein 1987). This programme should be continued selectively, by moving "problem animals from problem areas". Target areas in other reserves should be rich in preferred rhino

food plants and distant from settlements, such as Babai Valley in RBNP, to avoid similar problems as in Sauraha.

v) Education

The Park should provide for better training of local tourist guides and educate the tourists. The guides should be trained by knowledgeable, experienced wildlife experts. Materials about local wildlife, their habits and behaviour and problems associated with them should be developed and made available locally to educate tourists as well as local guides.

vi) Public favoured activities

Park authorities should address in earnest the question of local people participation. They should expand on the activities just started (thatch grass and fuelwood collection) by providing more benefits to local people, both directly and indirectly.

The increasing fuelwood demand and its pressure on park resources could be reduced by establishing plantations on public and government lands outside the Park (Edson et al. 1988) in participation with local people including Panchayats, the hotel association and schools. Such plantations can be established as a community woodlot or buffer zone in large grazing meadows in Bagmara area, between Hattisar and Dhungre river, and in Harnari. The physical barriers erected to protect these woodlots would reduce frequent movement of animals from park forests.

Multipurpose trees (Epil Epil, Lucinea species) and suitable indegenous species for fuelwood and fodder should be encouraged by providing seeds, seedlings and methods of plantation at minimum prices. Similarly, introduction of improved stoves, as suggested by Sharma (1986), would be helpful to minimize the increasing demand of fuelwood.

Earlier opening of the park for cutting thatch grass for hotels and other park associates develops frustrations among local communities, as most of the large and healthy thatch grass patches are cleared before public opening. This results in early burning. This problem should be solved by putting pressures on the Park users (hotel owners and army) to use permanent roof materials such as in the SINTEP camp.

Timber for building construction, erecting machans and fences should be made easily available to local people from dead trunks at minimum prices by establishing timber depots from park side.

Other people oriented activities from the park side such as establishing local health clinics, sports, night schools for old local farmers, nature conservation talk programs, debates, documentary shows (mainly prepared on the local level) in understandable language would be helpful to start conservation activities successfully. These efforts should be directed in such a way that local people understand the need and importance of such reserves for present and future generations.

The Government/Park authorities should increase their recent efforts to comply with the philosophy of modern conservation (IUCN 1984), namely that revenues generated from Parks and protected areas through tourism should be channelled back to pay for Park management and provide compensation and benefits to local people. This could be achieved by setting up a revolving fund for expenses to support local activities mentioned above and for compensation for crop damage. The total annual revenues to the Park from tourism (tourist entry fees, lease of elephants, royalities, etc.) are about 4,00000 Rs (RCNP, pers. comm.). The economic damage caused by rhinoceros was estimated at about 170000 Rs. in Sauraha, which is less than 5% of total Park income. Thus, financial resources are available of which some should be set aside to solve the growing Park/people problem in this area.

7. CONCLUSION

A heavy economic loss of 172500 Rupees was estimated due to damage to agricultural crops by rhinos in Sauraha area for the year 1988-89. About 100 households suffered damage. Among the crops, rice, mustard, maize, lentils and vegetables were most preferred. Economically, highest (27.6%) loss occurred in rice crops, mainly restricted to zone I, within a distance of 500 m of the park. Damage to mustard, lentils and kitchen gardens was distributed among all three zones because of poor guarding. Among farmers suffering rhino damage, the economic loss was estimated at about 2000 Rs./household. Between 50-60 rhinos resided in the general vicinity of Sauraha. 10-12 animals were recorded inside the agricultural fields every night, probably most often the same animals after having become habituated to humans and specialized on crop raiding. Machan guarding with mukka and trenches were among the most effective traditional means applied locally to remedy the problem. However, due to poor maintenance and lack of enough depth and less steepness, trenches were not as effective as intended.

Injuries and harassment to the local people is another growing problem in Sauraha. 78 accidents, where 23 were killed, occurred in a short time period of 10 years. Most accidents (89.7%) occurred outside of the park while collecting fuelwood/fodder, grazing cattle and protecting crops. Most accidents occurred among middle-aged men between 26-45 years, mainly Tharu

and Hill Matwalis. Several accidents also occurred among tourists, mainly due to carelessness, poor knowledge about animals and poor guiding.

The problem is increasing every year mainly due to an increasing rhino population and lack of effective physical barriers to stop freely moving animals. Disturbances by other human activities and degrading habitats inside the park due to excessive use of domestic elephants for tourism, grazing, and collection of feed and fuelwood, illegal livestock grazing, grass cutting and irregular burning contribute to increased crop raiding and human harassment.

In recent years, the government seems more concerned about local peoples' problems. Translocation of rhinos to other reserves, opening of park to local people for thatch grass and fuelwood collection are among such steps. Besides assisting with establishing more effective physical barriers to prevent rhino movement, Park authorities should expand on people-oriented programmes and provide compensation and other benefits to reduce the conflict between local people and the overall preservation objective of the Park.

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APPENDIX 1

DIFFERENT CROPS AND GARDEN PLANTS GROWN IN SAURAHA AREA AND DEGREE OF PREFERENCE BY RHINOS 1)

1. Cereals		
Dhan***	Rice	Oryza sativa
Ganhu***	Common wheat	Triticum aestivum
Jau**	Barley	Hordeum vulgare
Makai***	Maize	Zea mays
2. Millets		
Kodo***	Finger millet	Eleusine coracana
Junelo*	Sorghum	Sorghum vulgare
3. Pseudo cereals		
Latte dana*	Amaranthus	Amaranthus sps.
Mithe phaper**	Common buckwheat	Fagopyrum esculentum
Tite phaper**	Tatary buckwheat	Fagopyrum tataricum
4. Pulses		
Bodi*	Cow pea	Vigna sinensis
Bakula simi	Broad beans	Vicia faba
Bhatmash***	Soyabean	Glycine max

(* = low, ** = medium, *** = high preference)

1) Based on questionnaire and communication with locals.

Chana**	Gram	Cicer arietinum
Gahat*	Horse gram	Dolichos biflorus
Khesari**	Grass pea	Lathyrus sativus
Mash***	Black gram	Phaseolus mungo
Masuro***	Lantil	Lens culinaris
Masyang**	Rice bean	Phsaseolus calcartus
Rahar**	Pegeon pea	Cajanus cajan
Sano kerau*	Field pea	Pisum arvanse
Simi*	Common field beans	Phaseolus sp.

5. Edible vegetable oils

Aalash**	Linseed	Linum usitatissimum
Badam*	Ground nut	Arachis hypogaea
Bhatamash***	Soya bean	Glycine max
Chiuri	Butter fruit	Madhuca butyracea
Rayo**	Indian mustard	Brassica juncea
Sarsyun*	Indian cloza	Brassica campestris
Silam	Perilla	Perilla frutescens
Suryamukhi	Sunflower	Helianthus annus
Tori*	Indian rape	Brassica compestris

6. Spices

Aduwa	Ginger	Gingiber officinale
Besar	Turmeric	Curcuma domestica
Bojho	Sweet flag	Acorus calamus
Chhyapi	Shallot	Allium ascalonicum
Dhaniya	Coriandor	Coriandrum sativum
Jeera	Cuminseed	Cumin cyminum

Jwano	Lovage	Trachyspermum ammi
Khursani***	Red pepper	Capsicum frutescens
Lasun	Garlic	Allium sativum
Maroti	Basil	Ocimum basilicum
Methi	Fenu-greek	Trigonella foenum graecum
Pipla**	Long pepper	Piper longum
Pyaz	Onion	Allium cepa

7. Vegetables

Alu***	Potato	Solanum tuberosum
Babari	Common mint	Menthe aquatica
Bakula simi*	Broad bean	Vicia faba
Banda govi**	Cabbage	Brassica oleraca
Ban Tarul	Wild Edible Yam	Dioscorea sp.
Bhanta****	Egg plant	Solanum melongena
Bhadaure kankro	Garden cucumber	Cucumis sativus
Khursani***	Bell pepper	Capsicum frutescens
Bethe	Lamb's quarter	chenopodium album
Bodi**	Cow pea	Vigna sinensis
Chamsur	Granden cress	Lepidium
Chari amilo*	Indian soreel	Oxalis corniculata
Chichindo	Snake gourd	Trichosanthes anquina
Gazar*	Carrot	Daucus carota
Ghar tarul	White Yam	Dioscorea alata
Ghiraunla	Spong Gourd	Luffa cylindrica
Gitthe tarul	Air potato	Dioscorea bulbifera
Golbhenda*	Ordinary tomato	Lycopersicom

		esculentum
Gyanth govi*	Knol khol	Brassica oleracea
Halhale sag	Curly Doek	Rumex crispus
Hiunde simi*	Hyacinth beans	Dolichos lablab
Imili	Tamarind	Tamarindus indica
Iskus	Chayote	Sechium edule
Kabro	---	Ficus lacor
Karkalo	Co-co Yam	Colocasia antiquorum
Katahar	Jack fruit	Artocarpus heterophyllus
Kauli***	Cauliflower	Brassica oleracia
Kharbooza	Musk-melon	Cucumis melo
Koiralo	Pink Bauhinia	Bauhiniya purpurea
Kubindo	Ash Gourd	Benincasa hispida
Kurilo	Common asparagus	Asparagus officinalis
Kutulikosa*	Common Spring Vetch	Vicia sativa
Lauka	Bottle Gourd	Lagenaria siceraria
Latte sag*	Amaranth	Amaranthus leucocarpus
Lunde ko sag*	Pigweed	Amaranthus viridis
Matar***	Garden pea	Pisum sativum
Mula***	Radish	Raphanus sativus
Niuro*	Edible fern shoot	Dryopteris cochleata
Palango	Pricklyseeded	Spinacea oleracea
Pate Ghiraunla	Spinach Riged of Ribbed Gourd	Luffa acutangula
Pharsi	Vegetable marrow	Cucurbita pepo
Pidar	Edible Emietic nut	Randia uliginosa
Ramtoria*	Lady's finger	Hibiscus esulentus

Rayo ko Sag**	Broad Leaf mustard	Brassica juncea
Sakharkhanda**	Sweet popato	Ipomoea batatas
Simal***	Silk cotton	Bombax ceiba
Sim Rayo	Water cress	Nasturtium officin
Sisnu	Stinging Nettle	Urtica ardens
Sunp	Fennel	Foeniculum vulgare
Tama bans	Feathery Bamboo	Bambusa vulgaris
Tane bodi**	Aaparagus bean	Vinga sesquipedalis
Tarul	Cassava	Manihot esculentum
Tarbooza	Water Melon	Citrullus vulgaris
Tinda	Round gourd	Citrullees vulgaris
Tite karela	Bitter gourd	Memordica charantia
Tyammtar	Tree tomato	Cyphomamdra betacea

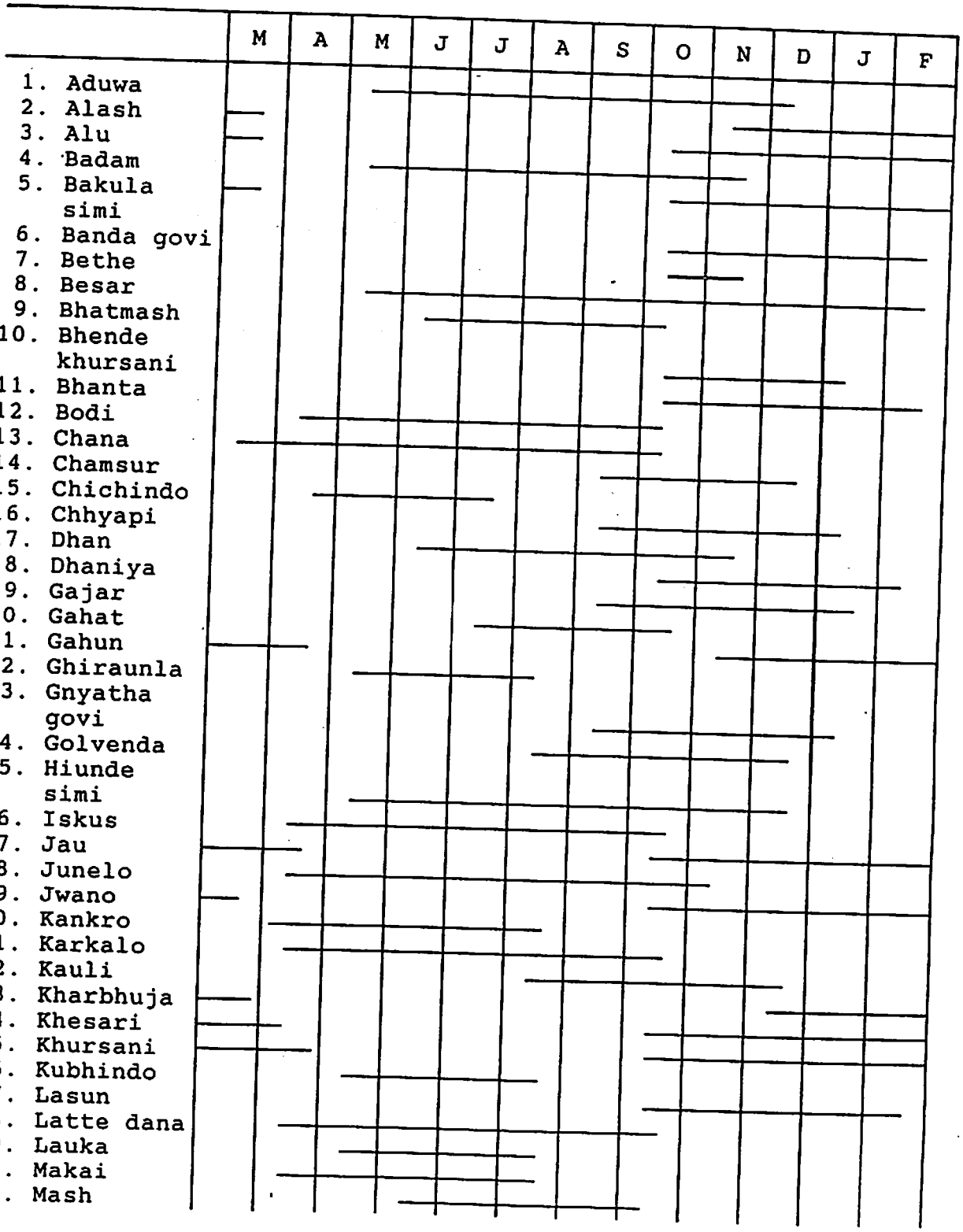
8.Fruit

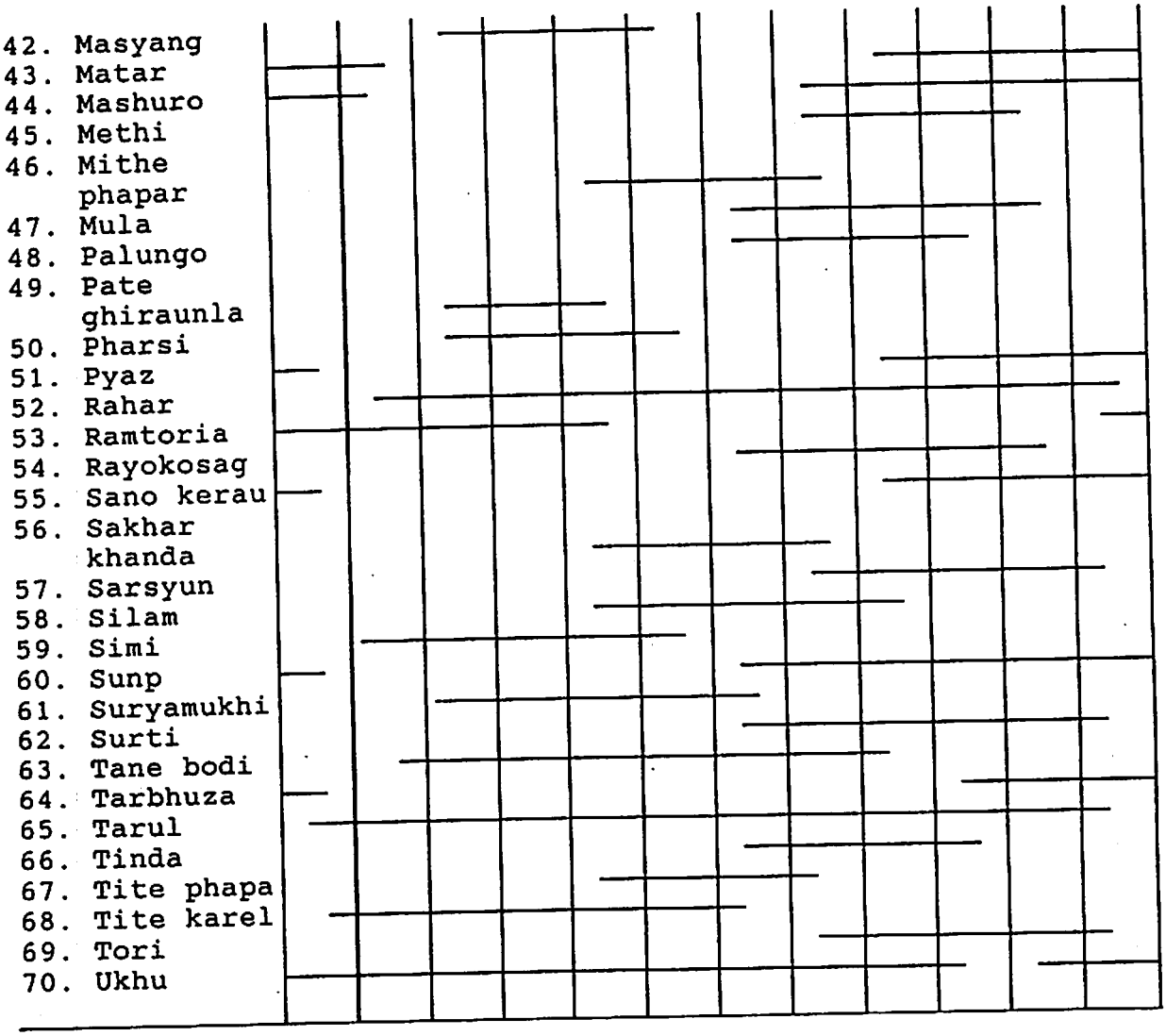
Alu Bakhara	Bullace	Prunus domesteica
Anp*	Mango	Mangifera indica
Anar,Darim	Pomegranate	Punica granatum
Amala	Myrobalan	Emblica officinalis
Amba	Guava	Psidium guajava
Aru	Peach	Prunus persica
Badahar	Monkey Jack	Artocarpus lakoocha
Bayar	Chinese Date	Zigyphus mauritiana
Bel	Bengal quince	Aegle marmelos
Bhogate	Pummelo	Citrus grandis
Bhuinkatahar	Pine apple	Ananas comosus
Bimiro	Citron	Citrus medica
Chiuri	Indian Butter tree	Madhuca butyracea

Gayo**	Cudaph Almond	Bridelia retusa
Gulab Jamun	Rose apple	Sizygium jambos
Harro	Yellow Myrobalam	Terminalia chebula
Jamum	Black pulm	Eugenia jambolana
Kadam	Kadam	Anthocephalus chinensis
Kagati	Lime	Citrus aurantifolia
Kera***	Banana	Musa paradisiaca
Khaneu	----	Ficus cunia
Kimbu	Black mulberry	Morus alba
Lichi	Litchi	Nephelium litchi
Naspati	Common pear	Pyrus communis
Nevaro	Common Fig	Ficus carica
Nibwa (Amilo)	Lemon	Citrus lemon
Papita (Mewa)	Papaw	Carica papaya
Rukh Katahar	Jack fruit	Artocarpus heterophylla
Saripha	Custard apple	Annona squamosa
Suntala	Mandarin	Citrus reticulata
Ukhu**	Sugarcane	Saccharum officinarum

APPENDIX 2

GROWING SEASON FOR DIFFERENT CROPS AND GARDEN PLANTS IN SAURAHA AREA




42. Masyang
43. Matar
44. Mashuro
45. Methi
46. Mithe phapar
47. Mula
48. Palungo
49. Pate ghiraunla
50. Pharsi
51. Pyaz
52. Rahar
53. Ramtoria
54. Rayokosag
55. Sano kerau
56. Sakhar khanda
57. Sarsyun
58. Silam
59. Simi
60. Sunp
61. Suryamukhi
62. Surti
63. Tane bodi
64. Tarbhuza
65. Tarul
66. Tinda
67. Tite phapa
68. Tite karel
69. Tori
70. Ukhu

APPENDIX 3

DAMAGE TO MAJOR CROPS - RICE, MAIZE, MUSTARD, LENTIL AND KITCHEN GARDEN PLANTS.

RICE

Mean yield (Y) in undamaged area = .315 kg/sq.m

Mean yield in damaged area in mature stage = .068 kg/sq.m

(Mean yield lost = .247 kg/sq.m)

Mean yield in damaged area in flowering stage = .041 kg/sq.m

(Mean yield lost = .274 kg/sq.m)

Mean yield in damaged area in early green stage = .295 kg/sq m

(Mean yield lost = .02 kg/sq.)

ZONE I

	Tot A dam h	$\bar{X}$ % A dam/ Hh	Tot Yield lost Mt	$\bar{X}$ % Y Lost	A dam/ Hh ha	Y Lost/ Hh Mt	Economic Value for tot loss Rs.	Eco Value loss/ Hh Rs.
Gr stg	0.38	22.48	0.1	17.11	.007	.002	380.00	6.8
Fl stg	3.89		10.6		.069	.189	40280.00	719.3
Mt st	2.69		6.7		.048	.120	25460.00	454.6
Total	6.96		14.4		.124	.311	66120.00	1180.7

The percentage of area damaged in zone I = 5.05 %
Percentage of farmers who suferred by damage = 35.22 %

ZONE II

	Tot A dam ha	$\bar{X}$ % A dam/ Hh	Tot Y lost Mt	$\bar{X}$ % Y Lost	A dam/ Hh ha	Y Lost/ Hh Mt	Eco Value for tot loss Rs	Eco value loss Hh Rs
Gr stg	-	-	-	-	-	-	-	-
Fl/er stg	.03	3.9	.08	3.0	.01	.04	311.3	155.6
Mat stg	.07		.17		.07	.17	646.0	646.0

The percentage of area damaged in zone II = .1%
Percentage of farmers who suferred damage=.1%

Table Individual households suffered from rice damage.for the 1988 89 growing season.

ZONE I

Hh no	Total A for rice m	Yield if no dam Kg	Area dam in gr stg m	Yield loss in gr stg Kg	Area dam in F/EM stg. m	Yield loss in FE stg. Kg	Area dam in Mt stg m	Yield loss in Mt stg Kg	% Yield loss/hh	% Area dam/hh
1	1700	544	33.1	0.7	103.2	28.3	223.1	55.1	15.5	21.1
2	4080	1305.6	72.0	1.4	56.6	15.5	545.0	134.6	11.6	16.5
3	5780	1849.6	-	-	401.6	110.1	-	-	6.0	7.0
4	1020	326.4	97.8	1.9	-	-	196.3	48.5	15.5	28.9
5	13600	4352.0	746.0	14.9	1023.7	280.5	1398.1	345.3	14.7	23.3
6	13600	4352.o	373.3	7.5	-	-	1732.7	427.9	10.0	15.5
7	12240	3916.8	-	-	423.2	116.0	466.1	115.1	5.9	7.3
8	7480	2393.6	231.1	4.3	530.1	145.3	-	-	6.3	9.9
9	5440	1740.8	-	-	926.9	245.0	201.2	49.7	17.5	20.7
10	4420	1414.4	66.2	1.33	279.1	76.5	181.2	44.8	8.7	11.9
11	12920	4134.4	23.5	0.5	132.7	36.4	1397.7	345.2	9.2	12.3
12	8160	2611.2	136.4	2.7	340.7	93.4	321.3	79.4	6.7	9.7
13	7140	2284.8	-	-	-	-	773.5	191.1	8.4	10.8
14	8840	2828.8	236.1	4.7	1342.2	367.8	-	-	13.2	17.9
15	2040	652.8	16.3	0.3	131.3	36.0	266.0	65.7	15.6	19.5

(A=area, dam=damage, gr=green, F/EM=floweing and earlymature, Y=yield Mt=mature and hh=household.

16	16660	5331.2			621.3	170.2	726.3	179.4	6.6	8.1
17	16660	5331.2	66.2	1.3	371.2	101.7	491.9	121.5	4.2	5.6
18	7820	2502.4	326.0	6.5	322.6	88.4	267.2	65.9	6.	11.7
19	1360	435.2	-	-	82.8	22.7	21.8	5.4	6.5	7.7
20	4420	1424.4	118.9	2.4	273.7	75.0	110.1	27.2	7.4	11.4
21	3060	979.2	-	-	-	-	926.6	228.9	23.4	30.3
22	3893	1245.8	44.0	0.9	153.7	42.1	289.7	71.6	9.2	12.5
23	7820	2502.4	-	-	1429.7	391.7	139.0	34.3	17.0	20.1
24	11220	3590.4	-	-	326.0	89.3	-	-	2.4	2.9
25	5780	1849.6	27.0	0.5	501.2	137.3	326.0	80.5	11.8	14.8
26	1020	326.4	-	-	-	-	624.2	154.2	47.2	61.2
27	5576	1784.3	27.7	0.6	360.0	98.7	51.1	12.6	6.3	7.9
28	1360	435.2	-	-	123.7	33.9	57.3	14.2	11.1	13.3
29	3060	979.2	29.0	0.6	726.0	198.9	-	-	20.4	24.7
30	7140	2284.8	-	-	226.8	62.1	329.1	81.3	6.3	7.8
31	6120	1958.4	-	-	223.8	61.3	729.1	180.1	12.3	15.7
32	1360	435.2	29.9	0.6	130.0	35.6	-	-	8.3	11.8
33	10880	3481.6	-	-	210.9	57.8	-	-	1.7	1.9
34	20400	6528.0	-	-	1132.7	310.4	171.0	42.2	5.4	6.4
35	3740	1196.8	-	-	220.0	60.3	647.4	159.9	18.4	23.2
36	2380	761.6	-	-	-	-	336.4	83.1	10.9	14.1
37	7480	2393.6	-	-	217.2	59.5	-	-	2.5	2.9
38	8500	2720.0	-	-	836.1	229.1	721.2	178.1	15.0	18.3
39	1020	326.4	-	-	-	-	326.9	80.7	24.7	32.1
40	30600	9792.0	-	-	2236.0	612.7	-	-	6.3	7.3

41	2040	652.8	-	-	622.3	170.5	76.0	18.8	29.0	34.2
42	680	217.6	29.0	0.6	17.3	4.8	-	-	2.5	6.2
43	6460	2067.2	-	-	276.8	75.9	126.2	31.2	5.2	6.2
44	2380	761.6	-	-	121.2	33.2	89.9	22.2	7.3	8.9
45	4080	1305.6	29.6	0.6	-	-	326.7	80.7	6.2	8.7
46	3400	1088.0	-	-	319.6	87.6	-	-	8.1	9.4
47	4760	1523.2	-	-	276.3	75.7	627.5	155.0	15.2	24.1
48	1700	544.0	77.4	1.6	-	-	332.1	82.0	15.4	24.1
49	24480	7833.6	236.0	4.7	323.4	88.6	800.1	197.6	3.7	5.6
50	2380	761.6	27.2	0.5	-	-	373.2	92.2	12.2	16.3
51	2720	870.4	-	-	-	-	436.7	107.9	12.4	16.1
52	4080	1305.6	-	-	-	-	786.8	194.3	14.9	19.3
53	2040	652.8	-	-	1498.8	410.7	241.2	59.6	72.0	85.3
54	1377	440.6	-	-	732.6	200.7	437.4	108.0	70.1	85.0
55	7820	2502.4	327.2	6.5	662.0	181.4	995.5	245.9	17.3	25.4
56	4080	1305.6	-	-	554.7	152.0	888.1	219.4	28.4	35.4

ZONE II

1.	13600	4352	-	-	174.6	47.9	680.0	167.9	4.9	6.1
2.	7480	3393.6	-	-	124.3	34.1	-	-	1.0	1.6

MUSTARD

ZONE I

	Tracks used 1 time			Tracks used 2 times			Tracks used >3 times		
	No trs.	Area ha	Est %	No trs.	Area ha	Est %	No trs	Area ha	Est %
Gr stg	109	5.0	10	10	.5	40	2	0.1	100
Fl stg	96	4.4	15	13	.6	70	4	0.2	100
Mt stg	67	3.1	10	4	.2	30	1	0.1	>80

Mean length of track = 920 m.

ZONE II

	Tracks used 1 time			Tracks used 2 times			Tracks used >3 times		
	No trs	Area ha	Est %	No trs.	Area ha	Est %	No. trs.	Area ha	Est %
Gr st	97	4.0	10	6	0.2	40	-	-	100
Fl stg	76	3.2	15	6	0.2	70	2	0.1	100
Mt stg	51	2.1	10	2	0.1	30	-	-	>80

(Mean length of tracks = 833 m

ZONE III

	Tracks used 1 time			Tracks used 2 times			Tracks used >3 times		
	No. trs.	Area ha	Est %	No. trs.	Area ha	Est %	No. trs	Area ha	Est %
Gr stg	12	0.4	10	-	-	40	-	-	100
Fl stg	7	0.2	15	2	0.1	70	1	0.03	100
Mt stg	4	0.1	10	2	0.1	30	-	-	>80

Mean length of tracks = 593 m

MAIZE

ZONE I

Farmers	Area dam. totally ha.	Yield lost Mt.	Area dam. Partially 50-60 % ha	Yield lost Mt.
1.	0.01	0.02	-	-
2.	0.03	0.05	-	-
3.	-	-	0.10	0.13
4.	0.04	0.09	-	-
5.	-	-	0.12	0.15
6.	-	-	0.07	0.09
7.	0.02	0.05	0.07	0.09
8.	0.07	0.16	-	-
9.	0.04	0.09	-	-
10.	-	-	0.13	0.17
11.	0.05	0.12	-	-
12.	-	-	0.10	0.13
13.	0.04	0.09	-	-
14.	0.05	0.12	0.10	0.13
Total	0.46	1.07	0.69	0.89

(Sample size = 35)

ZONE II

Farmer	Area dam. totally ha	Yield lost Mt	Area dam. partially 50-60 % ha	Yield lost Mt
1.	0.05	0.10	-	-
2.	-	-	0.03	0.05
Total	0.05	0.10	0.03	0.05

LENTIL

ZONE I

Farmer No.	Total area for lentil ha	Yield if no dam. Mt	Area damaged ha	Yield lost Mt	% Y loss	Eco. value Rs.
1.	.37	.74	.03	.06	13.5	360
2.	.14	.28	.03	.06	21.4	360
3.	.24	.48	.04	.08	16.7	480
4.	.07	.14	.08	.16	100.0	960
5.	.31	.62	.02	.04	6.5	240
6.	.20	.40	.03	.06	15.0	360
7.	.14	.28	.08	.16	71.4	960
8.	.14	.28	.05	.10	50.0	600
9.	.24	.48	.04	.08	16.7	480
	1.85	3.70	0.40	0.80		4800

(Sample size = 35)

Zone II

Farmer no.	Total area for lentil ha	Yield if no dam Mt	Area dam. ha	Yield loss Mt	% Y loss/	Eco. values Rs.
1.	.24	.48	.06	.12	25.0	620
2.	.54	1.04	.10	.20	19.2	1200
3.	.68	1.36	.02	.04	2.9	230
4.	.51	1.02	.07	.14	13.7	820
5.	.24	.48	.10	.20	41.7	1200
6.	.10	.20	.03	.06	30.0	220
7.	.07	.14	.01	.02	14.3	120
	2.38	4.72	0.39	0.78		4410

Zone III

Farmer no.	Total area for lentil ha	Yield if no damage Mt	Area dam. ha	Yield lost Mt	% loss	Eco. Value lost Rs
1.	.52	1.02	.07	.10	13.73	640
2.	.68	1.36	.03	.06	4.41	360
3.	.68	1.36	.10	.20	14.71	1040
	1.88	3.74	0.20	0.40		2040

VEGETABLES (Kitchengarden)

ZONE I

s.no.	Name of plants	No. of pt.org.	No. dam total	%	No.dam. part.	%
1.	Potato	15838	6403	40.4	3775	23.8
2.	Cauliflower	1759	545	31.4	1204	13.8
3.	Radish	6990	2600	43.4	3335	31.4
4.	Tomato	2305	126	5.5	55	2.3
5.	Onion	10530	-	-	-	-
6.	Broad Leaf mustard	12240	2033	16.6	1829	14.9
7.	Red pepper	1632	773	47.4	91	5.6
8.	Garlic	11427	-	-	-	-
9.	Bakula simi	745	96	12.9	137	18.4
10.	Palungo	525	-		-	-
11.	Carrot	725	12	-	-	-
12.	Eggplant	2519	1029	40.8	531	21.07
13.	Ginger	630	-	-	-	-
14.	Termeric	937	-	-	-	-
15.	Cabbage	1285	571	44.4	106	8.25
17.	Chhyapi	325		-	-	-

Percentage of farmers suffered with damage = 34.79 %

ZONE II

Name of Plants	No. of pt. org.	No.dam totally	%	No.dam Part.	%
1. Potato	16840	8165	48.5	5525	32.8
2. Cauliflower	2949	1091	36.7	277	9.4
3. Radish	5710	3200	56.0	1770	23.2
4. Tomato	4531	-	-	76	1.7
5. Onion	6201	-	-	-	-
6. Broad leaf mustard	9188	4721	51.4	3313	36.1
7. Redpepper	3981	2022	50.8	991	24.9
8. Garlic	1766	49	2.8		
9. Bakula simi	1946	216	11.1	63	3.2
10. Palungo	1447	-	-	-	-
11. Carro	2014	-	-	-	-
12. Eggplant	1537	629	40.9	101	6.6
13. Ginger	3001	-	-	-	-
14. Termeric	74	-	-	-	-
15. Cabbage	2098	871	41.5	32	.8
16. Chhyapi	626	-	-	-	-

Percentage of households suffered with damage = 22.1 %

ZONE III

Name of plants	No. of pt. org.	No. dam totally	%	No.dam pt. Part.	%
1. Potato	7426	1076	14.5	3211	43.2
2. Radish	629	270	42.9	66	10.5
3. Cauliflower	233	155	66.5	71	30.4
4. Cabbage	44	-	-	-	-
5. Eggplant	62	3	4.8	2	3.2
6. Red pepper	176	29	16.4	16	9.0
7. Garlic	341	-	-	-	-
8. Onion	75	-	-	-	-
9. Broad leaf mustard	3277	1923	58.7	349	10.6

Percentage of household suffered with damage = 1.8 %

APPENDIX 4

LOCAL MARKET PRICES FOR DIFFERENT CROP PRODUCTS ADN VEGETABLES DURING 1988-89.

1.	Rice	Rs. 4/kg
2.	Maize	Rs. 3.4/kg
3.	Lentils	Rs. 6/kg
4.	Mustark	Rs. 9/kg
5.	Cauliflower	Rs. 4/kg
6.	Potato	Rs. 5/kg
7.	Cabbage	Rs. 2.5/kg
8.	Eggplant	Rs. 4/kg
9.	Red pepper (green)	Rs. 10/kg
10.	Radish	Rs. .5/stick
11.	Broad leaf mustard	Rs. 1/bundle (5-10 leaves)

APPENDIX 5

MEANS TO REMEDY THE CROP DAMAGE PROBLEM

1. Name:---------- 2. Age:------

3. Sex:- 1. Male
2. Female

4. Occupation:-
1. Local farmer -----
2. Park warden -----
3. Local administrative officer -----
4. Army officer -----
5. Hotel owner -----
6. Naturalist -----

5. Experience in the study area:--------years.

6. Could you please suggest some better means to remedy these problems or which of the following means do you think better in this particular situation:-

1. barbed wire fence ----
2. trench ----
3. barbed wire fence and trench ----
4. electric fence ----
5. move people from the area ----
6. translocate all rhinos from the adjacent park area ----
7. kill rhinos which enter the fields ----
8. economic compensation for damage ----

7. If 6.8 How should damage be measured?

1. by park warden ----
2. by army officer ----
3. by Panchayat leaders ----
4. by farmer ----

8. Descriptive answers and Other reasoning:

Location etc.....
.....
.....
.....
.....
.....
.....
.....
.....

APPENDIX 6

PROBLEM ASSOCIATED WITH CROP DAMAGE

1. Ethnicity:----------
2. Age:-----
3. Sex: 1. Male
   2. Female
4. How much land do you have? ---------
5. What kind of crops do you grow in your field?
   1. Maize ----
   2. Wheat ----
   3. Rice ----
   4. Lentils ----
   5. Mustard ----
   6. Others 1.-----
      2.-----
      3.-----
6. Do you practice mix cropping system?
   1. Yes ---
   2. No ---
7. If 6.1, which crops do you plant combinely?
   1. ---------
   2. ---------
   3. ---------
8. Do you have any problem from park animals?
   1. Yes ---
   2. No ---
9. If 8.1, what kind of problems do you have?
   1. Crop damage ----
   2. Harassment ----
   3. Others -----
10. If 9.1, which animal mostly damage your crop?
    1. Rhinos -----
    2. Dears -----
    3. Wild boars -----
    4. Others 1. -----
       2. -----
       3. -----
11. If 10.1, how often do they enter the field?
    1. Every night ------
    2. 1-2 times per week -----
    3. 1-2 times per month------
    4. Occasionally-----
    5. Never -----
12. Do rhinos enter the field during the day time?
    1. Yes ---
    2. No ---
13. If 12.2, how do you identify the damage done by rhino?
    1. Last night you saw rhino entering field--------
    2. Last night you heard rhino noise in field------
    3. Foot prints ------------
    4. Grazing pattern------------

5. Any others 1.----------
2.----------
3.----------

14. Do you think baby rhinos damage more or less than the mother?
1. Yes ----
2. No ----

15. If 14.1, can you explain why?

---

16. Are rhinos selective on crops?
1. Yes -----
2. No -----

17. If 17.1, which crop do they prefer most?(list in order of preference)
1. Maize ----
2. Wheat ----
3. Mustard ----
4. Lentil -----
5. Rice -----
6. others 1.-----
2. -----
3. -----

18. Do rhinos damage equally in all growing periods?
1. Yes -----
2. No -----

19. If 17.2, when do they damage most?
1. Maize 1. Juvenile stage
2. When they are of waist height
3. Tasseling stage
4. Mature stage
2. Wheat 1. Juvenile stage ----
2. Medium stage ----
3. Mature stage
3. Mustard1. Juvenile stage ----
2. Flowering stage ---
3. Mature stage ----
4. Lentil 1. Juvenile stage -----
2. Flowering stage ----
3. Mature stage -----
5. Rice 1. Green stage ----
2. Flowering stage --
3. Mature stage ----
6. Others 1.---------- 1.---
2.---
3.---
2. ---------- 1. ----
2. -----

20. Did you have damage problem this year?
1. Yes---
2. No----

21. If 20, how much land was damaged from rhino?
a. Completely
Rice----
Maize---
b. Partially
Rice----
Maize----

Mustard----
Lentils----
Wheat------

Mustard-----
Lentils-----
Wheat-------

22. How much crop was lost from rhino damage this year?

	0-1%	1-10%	10-25%	25-50%	50-75%	75-100%
1. Rice	----	-----	------	------	------	------
2. Maize	----	-----	------	------	------	------
3. Mustard	----	-----	------	------	------	------
4. Lentils	----	-----	------	------	------	------
5. Wheat	----	-----	------	------	------	------

23. Do you apply some techniques to chase rhino from field?
    1.Yes ----
    2.No ----
24. If 23.1, what kind of techniques do you apply?
    1. Shouting and following ---------
    2. Following with fire ------
    3. Following with fire and shouting ------
    4. Following + throwing stones + shouting -----
    5. Scaring by hitting tin boxes -----
    6. Machan guarding ------
    7. All of these techniques -------
25. Does only your family chase rhino from field?
    1. Yes ----
    2. No ----
26. If 25.2, who else?
    1. Your neighbors -----
    2. All farmers in your village -----
    3. Farmers from neighboring villages ----
27. Do you grow all kinds of crop which are common in surrounding areas?
    1. Yes ---
    2. No ---
28. If 27.2, which crop not grown?
    1. Maize -----
    2. Wheat ----
    3. Mustard ----
    4. Lentil ----
    5. Rice ----
    6. Others 1.-----
              2.-----
              3.-----
29. If any from 28, why do you not grow?
    1. Difficult to grow ---
    2. Rhino damage problem -------
    3. Low yield -----
    4. Less market demand ----
30. If 28.2, would you prefer that crop if you had no rhino damage problem?
    1. Yes ----
    2. No ----
31. How much land would you allocate for that crop ?
    1. 25% ----
    2. 50% ----
    3. 75% ----
    4. >75% ----

32. If any from 27, how much yield would you get from this land area?
    ----------in local unit.
33. Do you leave some land area fallow during some period in the year due to rhino problem?
    1. Yes -----
    2. No -----
34. If 33.1, how much land do you leave fallow?
    ---------- in local unit.
35. Are you able to support your family from agriculture?
    1. Yes --------
    2. No --------
36. If 35.2, because part of your crops are destroyed by rhinos?
    1. Yes ---
    2. No ---
37. Do you think the damage problem is growing every year after the establishment of park?
    1. Yes ---
    2. No ----
38. Household no.-------
39. Zone----

APPENDIX 7

PROBLEM OF INJURY AND HARASSMENT

LOCAL PEOPLE

1. Ethnicity:----------

2. Age:------Years.
3. Sex:- 1. Male ---
2. Female ----

4. How often do rhinos attack and chase people in this particular area?

1. Every month -----
2. Every year -----

5. Was anybody in your family 1.Attacked 2.Chased by rhinos?

1. This year -----
2. Last year -----
3. Two years ago -----
4. Three years ago -----
5. Four years ago -----
6. Five years ago -----
7. No -----

6. If 5.1-6, How old was he/she? ------Years

7. How was he/she attacked?
   1. when grazing cattle outside the park -----
   2. when grazing cattle inside the park -----
   3. when collecting firewood/fodder inside the park -----
   4. when collecting firewood/fodder outside the park -----
   5. when just moving around -----
   6. when disturbing rhinos -----
   7. when chasing rhino out of cultivated field -----
   8. any other reasons:
      1 ----------
      2 ----------
      3 ----------

8. Can you tell how rhinos react when they see people?

   1. they attack immediately -----
   2. they standby and wait your reaction -----
   3. they make some threatening sound and attack -----
   4. they make threatening sound and run away from people--
   5. they just run away -----

Do you want to comment some more on this?

---

9. How does a rhino kill a person if he/she is already attacked?

---

10. If injured by rhino, do you receive any help or medical facility from park authority?

1. Yes -----
2. No -----

11. Is the aggressive behavior different in social groups like?

1. Yes-----
2. No------

12. If 11.1, which social group's react is most aggressive and dangerous?

1. Male -----
2. Female -----
3. Female with calf-----
4. Male with female -----

13. If you meet rhinos, how far do you feel safe?

1. Forest.------meters
2. Grassland----meters
3. Open meadow---meters

14. If you were attacked by rhino, how will you save yourself?

1 ----------
2 ----------
3 ----------
4 ----------
5 ----------

15. Do rhinos dislike some special color?

1. Yes ---
2. No ---

16. Which color?

1. White -----
2. Red -----
3. Blue -----
4. Green -----
5. Black -----

CIRCUMSTANCES OF ACTUAL KILL

1. Name:----------
2. Year:------
3. Age:----------
4. Sex: 1. Male----
   2. female-----

5. Time of death:---------
6. Place of death:--------
7. Physical condition:1. deaf---
   2. lame---
   3. blind---
   4. sick----
   5. drunk---
8. Situation when attacked----------

TOURISTS

1. Age:-----Years

2. sex:-
   1. Male ----
   2. Female ----

3. Nationality:--------

4. How long have you been here?
   1 ----days
   2 ----weeks
   3 ----month

5. How long will you stay ?
   -----days.

6. What was the main reason for you to come down to RCNP?

   1. to see wildlife -----
   2. to experience social life/local culture -
   3. to see landscape -----
   4. just to relax for some days -----

7. If 6.1, my knowledge about wild animals is:

   1. very good -----
   2. good -----
   3. fair -----
   4. little -----

8. Were you familiar with rhinos and rhino habits before?

   1. yes ---
   2. no ---

9. Have you received any information about rhinos when you came to Royal Chitawan National Park?

   1. yes ---
      1. from park authority -----
      2. from local guide -----
      3. written material -----
      4. oral information -----
   2. No ---

10. If yes, I received information about?

    1. social behavior -----
    2. feeding behavior -----
    3. aggressive behavior -----
    4. habit -----
    5. habitat -----
    6. general -----
    7. how to behave if rhino attacked

11. If yes to question 10.7, what kind of information?

---

12. Do you think you received adequate information about the rhinos in RCNP?

---

13. How did you travel in the jungle?

1. on elephant -----
2. on foot -----
3. on foot with guide -----
4. on foot without guide -----
5. on foot with friends -----
6. on foot alone -----

14. How often have you been close to rhinos when walking on foot?

1. one time -----
2. a few times -----
3. many times -----
4. never -----

15. What did you feel, when you saw a rhino in the jungle?

1. exciting -----
2. scared -----
3. normal -----

16. Have you ever been chased or attacked by rhinos?

1. Yes ---
2. No ---

17. If yes! how did you manage to escape from them?

---

18. If attacked and hurt did you receive any help from
    1. park authority --- 1. yes ---
                          2. no ---
    2. hotel --- 1. yes ---
                 2. no ---

19. If yes, what kind of help did you received?

APPENDIX 8

FIELD DATA FORM

Measurement of area and yield of damaged and control plots

1. Observation No:----

2. Plot No: -----

3. Date:---------

4. Crop --------

   1. planted in-----

   2. harvest in -----

5. Owner's name:----------

6. Location:- -------

7. Area measurement of damaged plot

   1. Length of transacts

      1-----cm/m ----------

      2-----cm/m ----------

      3 ----cm/m ----------

      4 ----cm/m ----------

      5 ----cm/m ----------

      6 ----cm/m ----------

      7 ----cm/m ----------

      8 ----cm/m ----------

   9. Sum Total length ----m

   2. Distance between transect:------cm/m

   3. Total area:- A = L . d

      =-------sq.m.

   4. Yield lost:------%

8. Control plots

   No. 1. Area:------sq.m. 1. Yield------

   No. 2. Area:------sq.m. 2. Yield------

No. 3. Area:------sq.m. 3. Yield------

No. 4. Area:------sq.m. 4. Yield------