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# Crop raiding and conflict: Study of Rhesus macaque-human conflict in Shivapuri-Nagarjun National Park, Kathmandu Nepal

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Natural Resources Management

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## Abstract

Crop raiding is one of the causes of conflict with Rhesus macaque (*Macaca mulatta*) mainly associated with farmers. Crop raiding depends on many factors such as season, spatial and temporal distribution of wild food resources, crop varieties, and distance from the forest. The objectives of this study was to compare the level of conflict and the attitudes of the respondents in two villages with high (Goldhunga) and low (Jhor Mahankal) crop raiding pattern. Three hypotheses were tested. First, the more crop raiding in Goldhunga area creates more negative attitudes towards the Rhesus macaques, second with the increase in distance from National Park boundary there is a decrease in crop raiding pattern, third, Rhesus macaques raid each crop equally. Results supported the first hypothesis but the last two hypotheses were not supported. Maize (*Zea mays*) was the most raided crops in both areas while the crops such as Turmeric (*Curcuma longa*), Bitter gourd (*Momordica charantia*), Chili (*Capsicum annum*), Ginger (*Zingiber officinale*) and Mustard (*Brassica nigra*) were least raided. The difference in level of crop raiding in the two study areas was due to more human activity and disturbance in Goldhunga area. Crop raiding is the foraging strategy of Rhesus macaques with small costs and great benefits. Rhesus macaques are clever at selecting sites where they can get more food. Rhesus macaques are pest species and persecuted by farmers in Nepal so they need fair management by the Government.

**Keywords :** *Crop raiding, Rhesus macaques, Attitudes, Shivapuri-Nagarjun National Park*

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# 1. Introduction

## 1.1. General Background

The human-wildlife conflict is one of the most critical threats facing many wildlife species (Dickman 2010). Carnivores are nuisance because of livestock depredation and attacks on humans. Crop raiding is one of the causes of conflict from herbivorous animals which is mainly associated with farmers. Non-human primates are one of them. The competition between human and non-human primates is a major problem (Priston & Underdown 2009). In some areas they are sharing the same food resources (Lee & Priston 2005). Primates are, however, more responsible for crop raiding when compared to other animals especially in Asia. In south Asia conflicts between humans and the Rhesus macaques (*Macaca mulatta*) seems to increase (Pienkowski et al. 1998).

Local people utilize the resources from the protected areas such as fodder, fuel wood etc (Seeland 2000). This can affect the amount of food available for Rhesus macaque in the long term inside Protected Areas. This may result in crop raiding from adjacent villages. Not only in the farms, Rhesus macaques are also responsible for the damage in garden plants and fruits (Long 2003). The primates raid crops and fruits in the absence of sufficient foods. Therefore, the problem of monkeys and conflict with people is increasing (Chalise 2013).

Locals are paying high costs while living with them imposing losses on farmers by destroying crops and wasting energy and finances while trying to protect fields (Hill 2002). In Uganda, the cost of crop raiding by primates and guarding varied from US\$ 96-519 per household per year (Hill 1997). Likewise, in Kenya, crop raiding costs US\$ 200-400/ households/year (Sillero-Zubiri & Switzer 2001) which is a large amount of money in comparison to their daily income.

The raiding of crops depends on many factors such as season, spatial and temporal distribution of food resources, crop varieties and characteristics, wild food availability, distance from the forest as well as distance from other farms (Hill 2000; Warren et al. 2007). The villages which are located in the boundary of National Park have different pattern of crop raiding. In some villages the crop raiding is more and in others it is less. So how do Rhesus macaques choose the sites for crop raiding? This is a question of interest.



Some studies have reported high crop raiding within the distance of 100 m from the forested area while it is negligible on the farms located beyond 300 m from the forested areas (Hill 1997). Not only the distance from the farm, the presence or absence of other neighboring farms also affect crop raiding (Hill 2000). Therefore, the development of agricultural projects near protected areas are not recommended (Saj et al. 2001). The altitude of the area also affects the wild food availability. With increase in altitude there is a decrease in food abundance and varieties in the forest . So the lower elevations normally have a higher population density of monkeys (Neville 1968). Besides crop raiding physical aggression towards the people, snatching bags, damaging property, stealing food and raiding garbage are other factors of conflict (Waters 2008). Attacks on humans are also recorded in some primate populations (Southwick & Siddiqi 1994).

Most of the researchers have focused on the crops which are frequently raided by Rhesus macaques but very few studies are available for the crops which are not raided by Rhesus macaques. For the farmers, it is very important to know the least raided crops by Rhesus macaques.

There is not uniformity on the use of controlling methods. Although some common methods used in all the communities are escorting, domestic dogs, catapults (using a stone in a rubber), and use of scarecrows etc.

## **1.2. Perception and status of Rhesus macaques in Nepal**

Rhesus macaques reside in most of the temples of Nepal. This species depends mostly on human food for their survival in temples. People distribute foods for them as good deeds. Rhesus macaques are believed to have relation with the God Hanuman in Hindu mythology. Although this species is considered holy in most of the South Asian countries, their behavior outwards the belief of local people (Medhi et al. 2007). Many people have been badly scratched, injured and bitten by Rhesus macaques in urban and or suburban areas of Bangladesh. In turn, they are also facing retaliatory killing, severe injury and extreme hate from people (Ahsan & Uddin 2014). In Nepal the species has similar problems.

Among Nepalese people if a person do a lot of mistakes they are named as monkey because of their notorious behavior. There is a saying in Nepali "A monkey does not make his own home and don't allow others to make their home" because they destroy everything. This shows the

perception of people towards them. Some people recognize that monkeys steal edible foods from their home and refer to them as ‘thieves’. They are also believed to be ‘clever’ (Hill & Webber 2010).

The Government of Nepal has not listed this species in the protected list while they are protected in India (Pirta et al. 1997). In Nepal, they are killed by farmers and regarded as pest. If the species is not protected then there is more chances to exploit that animal. If they are declared as protected species, people want to see them inside the park. These attitudes make it more difficult to protect the species (Osborn & Hill 2005).

Most of the primates are threatened from hunting, capture for captive colonies and research (Dobson & LEES 1989). Nepal was one of the South Asian countries exporting Rhesus macaques to the United States laboratories for research and experiments. But in 2009 the government banned its export after the immense objection from public and NGOs (Non-Governmental Organizations).

### 1.3. Study species

Rhesus macaque is a common name and Zimmerman termed the name *Macaca mulatta* in 1780. The body weight is 3-12 kg with a life expectancy of 20-30 years. They live solitary or in groups of 8-180 individuals, home range is 0.05-16 km<sup>2</sup> and their food is mainly based on vegetation (fruit, berries, grains, buds, seeds, grass, flowers, bark and also some insects). IUCN has listed the species as common but it is declining gradually (Long 2003).

There are six species of monkeys found in Nepal the macaques - Rhesus and Assamese (*Macaca assamensis*) and the Hanuman langurs (*Semnopithecus ajax*, *Semnopithecus hector* and *Semnopithecus schistaceus*) (Chalise 2013).

Primates are problematic because control measures are usually not successful (Strum 1994). At the central level it is a menace as the other techniques used for chasing wild animals are not effective in their case. Most herbivores such as Asian elephant (*Elephas maximus*) and Wild boar (*Sus scrofa*) can be controlled by fences, barriers and repelled by electric wires. Culling is also ineffective in case of Rhesus macaques because after the initial deaths, the remaining ones learn extreme caution but continue to raid (Strum 1994).

Approximately 90% of the world's primates are threatened by extinction. Increasing human population, deforestation, fragmentation of habitats, illegal poaching and trading are some threats to primate populations worldwide (Khatun Habiba 2010). In Nepal they are mostly threatened by the farmers because of crop raiding.

#### **1.4. Why does attitude matters?**

Attitudes of local people are very important in shaping the future of conservation programs. These attitudes help to make policies, management plans and decide sustainability of resources. Locals should always feel that resources are part of their life and it's their responsibility to preserve those resources for them and their future generation. The issues like climate change, pollution and use of chemicals (fertilizers, herbicides, pesticides) will destroy the resources over long term. But the attitudes are those strong weapons which influences the wildlife instantly. Primates are facing high degree of threats from humans. Negative attitudes are creating more problems. Even the big budgets conservation programs may fail because of people's attitudes. It's the people who are superior to all animals so their perceptions matters a lot. Public opinion plays a vital role in the planning and management of wildlife (Chauhan & Pirta 2010b). Studies of attitudes are important for public understanding, acceptance and the impact of conservation interventions (Holmes 2003). People getting the values associated with conservation, expect a positive affection for the activity that promotes conservation (Lynne et al. 1988).

People have more negative attitudes according to the amount of crop raided by the primate. These attitudes will determine the behavior of local people towards those animals (Røskaft et al. 2007). Attitudes of people determine the ecological behavior (Kaiser 1996). Rhesus macaque is termed as pests (Lee & Priston 2005), weeds (Richard et al. 1989) and invasive (Engeman et al. 2010). Pests are the insects causing damage to property and life of people. Weeds are the plants thriving where people leave their mark on the land. They spread in the travelling routes of people and settle down. While doing this, they depend on people and in fields they compete with people (Richard et al. 1989). Invasive can flourish even under harsh conditions and can sustain for longer period and cause nuisance. Rhesus macaques with all these characteristics have created negative attitudes towards them. Proper management of their population seems difficult under such a scenario.

## **1.5. Factors affecting conservation attitudes**

The conservation approach of fences, fines and fortress conservation accelerates the conflict and increases the retaliatory activities by locals against wildlife. Local communities experiencing more costs from wildlife conservation are less likely to support protected areas, whereas those receiving the benefits are more supportive (Kideghesho et al. 2007). Governmental policies and implementation are important in the conservation of any species.

Local's livelihoods depend upon the income generated from the farm. Crop raiding means huge loss for them. This enhances the negativity. Moreover, locals need direct benefits from the wildlife conservation rather than indirect benefits. Poor people can't afford to conserve those animals which are causing food deficiency because of crop raiding.

Likewise, animals that visit farms on a daily basis as compared with those that are seasonal raider's have different impacts on farming households. Additional problems arise when the animals causing crop damage are not protected because they can be killed mercilessly.

Moreover, the financial status of people is one of the important factors in determining an attitude towards the conservation programs (Sarker & Røskaft 2011).

## **1.6 Aim of the Study**

1. To compare two areas with high and low levels of crop raiding near the boundary of the national park.
2. To study attitudes of people towards the Rhesus macaque in relation to level of crop raiding.
3. To study most raided crops by Rhesus macaques.

## 2. Materials and methods

### 2.1 Study area

The study areas are located on the boundaries of Shivapuri Nagarjun National park in Kathmandu, Nepal (Fig.1). The Rhesus macaques live in 159 km<sup>2</sup> (Fig.1) area which is one of the natural habitats of the monkeys in Nepal. The Rhesus macaque population in this area is around 120 individuals distributed in six troops (Chalise 2009). It is situated on the northern part of Kathmandu valley and lies about 12 km away from the center of the capital city. In 2002 the area was declared as a National Park. It lies in a transition zone between the subtropical and temperate climates. The flora is dominated by Pine trees (*Pinus roxburghii*), Oak trees (*Quercus semecarpifolia*) and Rhododendron trees (*Rhododendron arboreum*). Animals like Himalayan black bear (*Ursus thibetanus*), Leopard (*Panthera pardus*), Jungle cat (*Felis chaus*), Barking deer (*Muntiacus muntjak*), Pangolin (*Manis pentadactyla*), Wild boar (*Sus scrofa*), Hanuman langur (*Semnopithecus ajax*) and Rhesus macaques (*Macaca mulatta*) are the main attraction of the area. It is also a home of 177 species of birds, including 9 threatened species, 102 species of butterflies and 129 species of mushrooms. (<sup>1</sup><http://www.dnpwc.gov.np/index.php/page/1>).

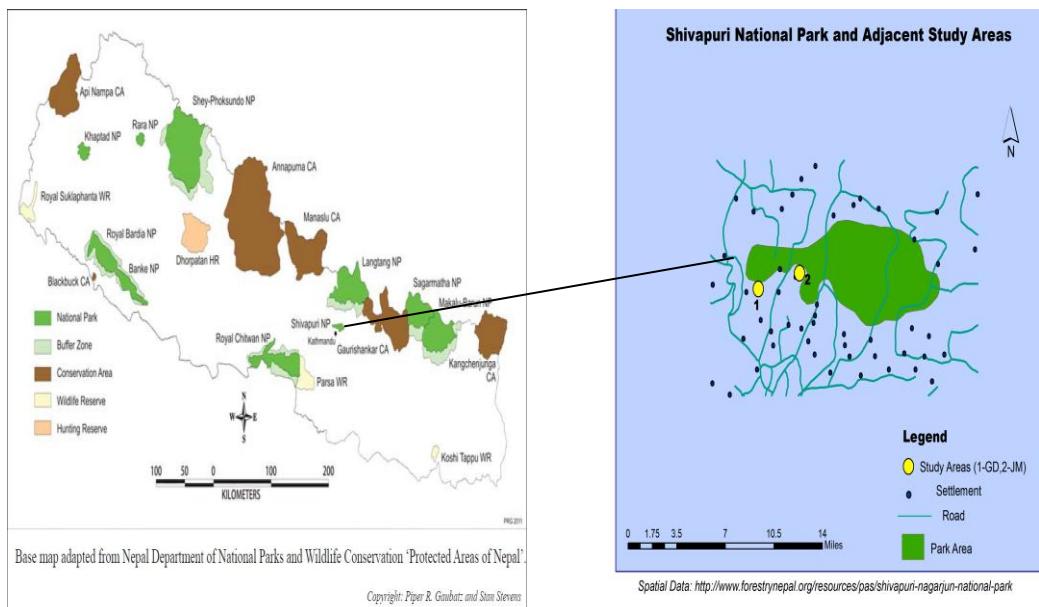


Fig. 1 Map showing the Protected Areas of Nepal and the study areas

<sup>1</sup> Retrieved on 23/01/2015 <http://www.dnpwc.gov.np/index.php/page/1>

The Jhor Mahankal Village has 873 households with the total population of 4103 individuals. Jhor Mahankal is situated at 27° 47' 51.8" (27.7977°) north 85° 20' 14.7" (85.3374°) east with average elevation of 1,605 meters (5,266 feet). Jhor Mahankal is a part of Shivapuri forest.

The Goldhunga area has a human population of 16,174 individuals with 3,806 households (Central Bureau of Statistics 2011). Goldhunga is situated at 27° 54' 37.5" (27.9104°) north 83° 3' 25.8" (83.0572°) east with the average altitude of 1,424 meters (4,672 feet) above sea level. Goldhunga is a part of Nagarjun forest.

## **2.2 General methodology**

Questionnaire survey was carried out in the two study areas. The face-to-face interview was taken with structured questionnaires. Both open-end and closed-end questions were asked. The selection of households was based on the random selection method. Most locals were engaged in agriculture in these areas. The households were interviewed based on their willingness. The households were divided into two categories i ) up to 1 km and ii ) 1 to 2 km. Among these two sites Goldhunga area had higher level of crop raiding by Rhesus macaque while Jhor Mahankal area had a lower level of crop raiding. To know this, a pilot survey was done in two sites before the questionnaire survey. Altogether 100 households were studied (50 households from each site). The questions were asked by the researcher in Nepali language with the help of one assistant. The main collected information included the crops which were not raided, crops raided by Rhesus macaques, crop raiding season, controlling methods, change in behavior of Rhesus macaques and attitudes of local people towards them. The collected data was analyzed with the help of SPSS (Statistical Package for Social Science) 21 version.

### 3. Results

#### 3.1. Crop Raiding

##### *A. Crop raiding*

There was a significant difference in crop raiding between the two study sites ( $\chi^2 = 20.92$ ,  $df = 3$ ,  $P < 0.001$ , Table 1). The risk of crop raiding was highest in the Goldhunga while Jhor Mahankal areas had lower risk of crop raiding (Table 1). Maize was the most raided crop, particularly in the Goldhunga area. Wheat and potato were raided at lower frequencies than maize (Table 1).

*Table 1* Frequencies of crop raiding in the two study sites

Study sites	Most frequently raided crops(N)				Total
	Maize	Wheat	Potato	None	
Jhor mahankal	15	9	8	18	50
Goldhunga	33	5	10	2	50
Total	48	14	18	20	100

##### *B. Crop raiding seasons*

The crop raiding was highest in the spring (45%) followed by the rainy season (39%) while it was lowest in the winter (16%). Crop raiding differed statistically significantly in relation to seasons between the two villages ( $\chi^2 = 9.37$ ,  $df = 2$ ,  $P = 0.009$ , Table 2).

*Table 2 Seasons of crop raiding in the two study sites*

Study sites	Raid season			Total
	Rainy and summer (June-August)	Spring (March-May)	Autumn (September-November)	
Jhor mahankal	25	22	3	50
Goldhunga	14	23	13	50
Total	39	45	16	100

### *C. Main crops in the farm and crop raiding*

There was a statistically significant difference in crop raiding pattern in the farms and the main crops which were grown ( $\chi^2 = 13.54$ ,  $df = 6$ ,  $P = 0.035$ , Table 3). The main crop grown in the farms was maize which was also one of the most raided crops.

*Table 3 Relation between the main crops grown in the farm and the crops being raided*

Main crops grown in the farms	Main crops raided in the farms				Total
	Maize	Wheat	Potato	None	
Maize	29	7	8	8	52
Rice	15	4	7	3	29
Other crops	4	3	3	9	19
Total	48	14	18	20	100

### *D. Controlling methods*

The controlling methods were escorting (52%), use of stones (7%), and 15% of respondents said they used all methods while 26% of the respondents said they didn't use any controlling methods to chase the Rhesus macaques away ( $\chi^2 = 41.03$ ,  $df = 3$ ,  $P < 0.0001$ , Table 4). 5% of respondents revealed that they injured Rhesus macaques while chasing them.



*Table 4 The use of control methods to chase Rhesus macaques in two sites*

Study sites	Controlling methods used to chase Rhesus macaque				Total
	None	Escorting	Stone	All the methods	
Jhor mahankal	25	24	1	0	50
Goldhunga	1	28	6	15	50
Total	26	52	7	15	100

***E. Change in behavior of Rhesus macaque***

Twenty eight percent of the respondents said Rhesus macaques were more aggressive and they were not afraid of people in Goldhunga. The respondents of Jhor Mahankal area felt that Rhesus macaques were less aggressive (16%). There was a statistically significant difference in the behavior of Rhesus macaque between the two study sites ( $\chi^2 = 48.09$ ,  $df = 2$ ,  $P < 0.0001$ , Table 5).

*Table 5 Types of behavior change among Rhesus macaques in two villages*

Study sites	Type of behavior change			Total
	No change	More aggressive	Not afraid of people	
Jhor mahankal	32	16	2	50
Goldhunga	1	28	21	50
Total	33	44	23	100

***F. Comparison of crop raiding among houses located at different distance from the national park***

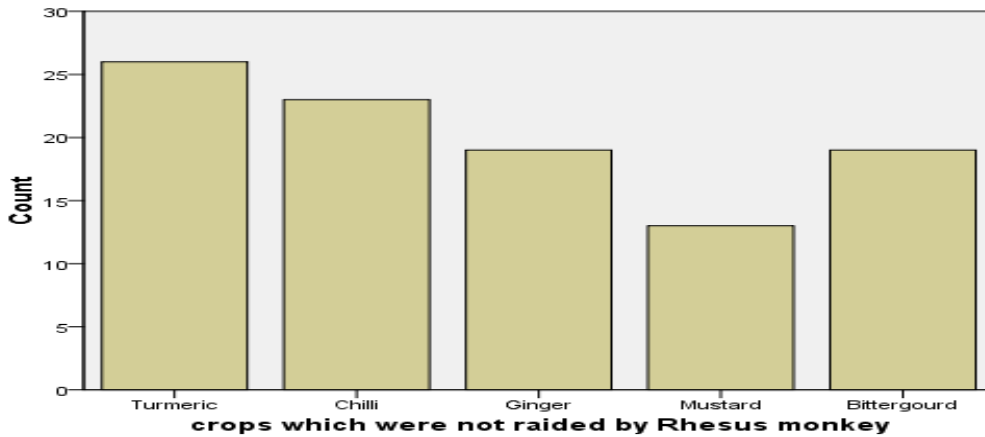
There was no significant difference in the crop raiding between the two study sites with respect to the distance from national park ( $\chi^2 = 4.22$ ,  $df = 3$ ,  $P = 0.238$ , Table 6). Rhesus macaques raided all the major crops regardless of the distance from the national park.

*Table 6 Comparison among households located at different distance from national park*

Distance from NP	The main crops being raided				Total
	Maize	Wheat	Potato	None	
Up to 1 km	27	8	12	7	54
1 to 2 km	21	6	6	13	46
Total	48	14	18	20	100

**G. Crops which were not raided by Rhesus macaques**

Crops which were not raided by Rhesus macaques were Turmeric, Chili, Ginger, Mustard and Bitter gourd.



*Figure 2 Showing the crops which were not raided by Rhesus macaques*

**3.2 Attitudes of people**

**A. Reasons to like Rhesus macaques**

Most people said there was no reason to like monkeys (73%). Ten percent of the respondents said that they were animal lovers and 17% of the people said that Rhesus macaques had the right to live. The reasons to like Rhesus macaques were significantly different between two study sites ( $\chi^2 = 37.97$ ,  $df = 2$ ,  $P < 0.0001$ , Table 7).

*Table 7 Reasons to like Rhesus macaque in two study sites*

Study sites	Reasons for liking Rhesus macaques			Total
	None	Animal lover	Right to live	
Jhor mahankal	23	10	17	50
Goldhunga	50	0	0	50
Total	73	10	17	100

***B. Reasons to dislike Rhesus macaques***

Crop raiding was the most important reason to dislike Rhesus macaques (58%) while 15% said that Rhesus macaques snatched things from people. The reasons given to dislike Rhesus macaques differed significantly between the two study sites ( $\chi^2 = 37.53$ ,  $df = 2$ ,  $P < 0.0001$ , Table 8).

*Table 8 Relation between dislike reasons and study sites*

Study sites	Don't like reasons			Total
	None	Snatching things from people	Crop raiding	
Jhor Mahankal	27	6	17	50
Goldhunga	0	9	41	50
Total	27	15	58	100

## 4. Discussion

### 4.1. Crop Raiding

Jhor Mahankal area had less crop raiding in comparison to Goldhunga area. This can be discussed with the foraging strategy of Rhesus macaques. As Strum (1994) assumed that crop raiding is the foraging strategy with specific cost and benefits in the case of Olive baboons (*Papio anubis*) in Kenya. Activity budgets, growth, condition, reproduction, injury and mortality of raiders and non raiders showed that raiders benefit more (Forthman-Quick & Demment 1988). Not only this, raiders grow faster, reach adulthood earlier and achieve higher final weights than non raiders (Eley et al. 1989). There are direct and indirect benefits associated with raiding. It is beneficial to be raiders as they spend less time feeding, more time resting and socializing which increases their long term fitness in terms of growth and reproduction (Eley et al. 1989). Besides this, the female raiders have shorter inter birth intervals than non raider females which increases their long term survival (Strum 1994). However, there are costs also which are associated with injuries and deaths from conflict with humans which are minimal compared to all the benefits.

Rhesus macaques raided maize frequently in both study areas. This may be due to the high foraging efficiency with maize. One ear of maize (*Zea mays*) is equivalent to a large harvesting effort for natural foods. Therefore, maize provides them a good source of food with high energy value. Actually most of the human food gives more energy per unit of effort (Forthman-Quick & Demment 1988). During field survey it has been found that maize was raided throughout their growth stages. Maize is planted on the onset of the rainy season and it takes almost three-four months to get harvest. Rhesus macaques ate seed of maize while it was in the farm. Usually they destroy crops and farms even if they are not in the edible state.

The value of human food and food availability made them to dwell nearby forests which are mainly disturbed forests. In the disturbed areas they get more food which gives them more benefits. Rhesus macaques in the northwestern Pakistan, showed preference for feeding on plant species of heavily disturbed parts of the forest (Iy Menard 2004; Richard et al. 1989). Among the 645 groups of Rhesus macaques, studied by Southwick et al. (1965) in India, all but mostly 8 groups lived in close association with people (Southwick & Siddiqi 1966). The another reason of crop raiding in disturbed habitats could be that the crops near forests are often predictable and

accessible sources of nutrition and raiders slept at the sites close to human food at almost 98% of their time (Strum 2010). So, Rhesus macaques select sites which have more human activity.

Discussing about the forest food availability, Kristen and Thomas (1999) found that the Zanzibar Red colobus monkeys (*Procolobus kirkii*) consumed more cultivated coconuts when there was scarcity of food in the forests (as cited in (Siex & Struhsaker 1999). Likewise, the development of raiding behavior was because of reduction in natural forage available to the Olive baboons in Kenya (Strum 1994). In case of Rhesus macaques in Shivapuri-Nagarjun National Park, it is very important to conduct further research on the population distribution and food availability in the forest.

Most crops were raided in the spring season in both study sites. This season has most of the crops and fruit plants with buds. Winter season had the lowest frequency of crop raiding in the two study areas. A study conducted on the Rhesus macaques in the Taihang mountains of China also showed that there were plenty of food inside the reserve in the summer and spring season but very less food in the winter season (Wenyuan et al. 1993). The seasonality is directly related with the maturity of crops. In general, most of the food plants flowered in March and April and fruiting peaked in May while major food plants and fruiting peaked in June and July. This is the main reason for crop raiding during the spring season. The food consumed in this season determines the growth and reproduction in Rhesus macaques.

Escorting was the most used way to control Rhesus macaques which needs time and labor. Especially women and children were guarding in the farms but Rhesus macaques were not afraid of them. Olive baboons in Kenya were more afraid of men than of women or children and with people having weapons (Strum 1994). Fencing could be a solution to other problematic herbivores. But in case of Rhesus macaques, fencing is not considered suitable technique as they can easily jump above the fences. Besides this the maintenance of these fences are important and may be more expensive (Nakagawa et al. 2010). During the field survey it has been found that Rhesus macaques were not afraid of scarecrows and in some places they were playing with them.

The Rhesus macaque was more aggressive in the Goldhunga in comparison to Jhor Mahankal area. Here aggressiveness means their behavior towards the villagers residing in that area. This was identified as felt by the respondents. Devi and Saikia (2008) found that Rhesus macaque

poses lots of threat to the women and children because they bit mostly women and children in the Guwahati India (Devi & Saikia 2008). In the two villages the women and children were affected by the Rhesus macaques as Rhesus macaques were not afraid of them. Women and children had fear to walk alone. It may be because these groups of people were involved in chasing the Rhesus macaques away from the farms. In Jhor Mahankal area Rhesus macaques were less aggressive, this may be due to fewer interactions between humans and Rhesus macaques. Teas et al. (1982) found that Rhesus macaque is the most quick tempered of the nonhuman primates. The aggression gives maximum return for Rhesus macaques from the minimum investment of energy. Extreme cases of aggression were chasing and attacking (Teas et al. 1982). While doing this they are also injured by humans, caused permanent scars and physical deformities (Brennan et al. 1985).

In Goldhunga area more human disturbance is giving them more chances to get food. While competing for food they may display more aggressive behavior. Chauhan and Pirta (2010) had found that Rhesus macaques in India were engaged in snatching and stealing the non-edible objects of people as a strategy to obtain food. Sometimes, they snatch spectacles, mobile phones, hand purses or shoes to get the food (Chauhan & Pirta 2010a). Gumert (2008) (as cited in (Chauhan & Pirta 2010a) has also observed that most of the agonistic interactions between humans and monkeys occurred for food and space. So, the aggressive behavior can be related as competing behavior.

Rhesus macaques raided crops regardless of the distance from the national park. They trampled the farm crops and ate the seeds. On the contrary, the Rhesus macaque population in India raided more crops in the farms located up to 2 km from the Sariska Tiger Reserve than the farms located up to 2-4 km away. Besides the distance, the location of the village and wildlife distributions in the protected areas also affected crop raiding (Sekhar 1998). Likewise, Linkie et al (2007) also found that farms closest to Kerinci Seblat National Park, Sumatra were most frequently raided by Wild boar and Pig-tailed macaques (*Macaca nemestrina*) where the distance from the National Park varied from 0 - 2.5 km (Linkie et al. 2007). A study by Studsrød and Wegge (1995) in the Royal Bardia National Park, Nepal, reported that seriousness of crop losses varied considerably with distance from the Park's border and specific location of households.

## 4.2. Attitudes

Attitudes are determined in terms of like or dislike of respondents and the reasons associated with it. In the study area most of the respondents living in the Goldhunga (more crop raiding) had more negative attitudes. The reasons associated with them are also different. Most respondents said the crop raiding was the first reason to dislike the Rhesus macaques. Respondents in the Jhor Mahankal area revealed that they were more flexible towards the Rhesus macaques and their behavior. While it was opposite with the respondents in the Goldhunga area. According to Røskaft et al. the people living nearby the protected area have less willingness to conserve them while the people living far from the protected area prefer them and have positive attitudes (Røskaft et al. 2007).

This study showed that people had more negative attitudes in the area with high crop raiding in comparison to the area with less crop raiding. This has also been shown by other Rhesus macaque study. Southwick and Siddiqi (1961) believed that the Rhesus macaque populations of northern India were declining because of changing attitudes of the villagers of India toward Rhesus macaques. Most villagers were not tolerant of extensive crop depredations by Rhesus macaques in India (Southwick et al. 1961). This was also noted during the questionnaire survey in the two study areas. Five percent of the respondents said that they injured Rhesus macaques while chasing them. This is also a part of lower tolerance by local people. The study by Holmern et al. (2007) in Tanzania about large carnivores found that majority of the people said carnivores should be killed as a response to livestock depredation, because they cause loss to farmers (Holmern et al. 2007). In study areas, respondents wanted to kill Rhesus macaques in response to crop raiding.

Compensation by the park authorities can mitigate the negative attitudes. But it is difficult to quantify the amount of time invested in cultivating the crop. The opportunity costs associated with the children not attending school to guard farms and women investing more time in farms rather than households are also difficult to assess. Some farmers get compensated just for the seeds which are often after long procedures involving many units. Usually the VDC (Village Development Committee) is the local unit where the farmers can appeal for their damage. There are also chances of overstating the damage. These makes compensatory programs more difficult

and the loss associated with them is one of the important factors shaping the attitudes of people including youth and children (Linkie et al. 2007).

### 4.3 Crops grown vs. crops raiding

The Rhesus macaques being the clever animal didn't raid the crops which are bitter or hot in taste such as Turmeric (*Curcuma longa*), Bitter gourd (*Momordica charantia*), Chili (*Capsicum annum*), Ginger (*Zingiber officinale*) and Mustard (*Brassica nigra*). Shekhar (1998) found that the Mustard plants (*Brassica nigra*) in India were not raided by Nilgais (*Boselaphus tragocamelus*) and Wild boars (Sekhar 1998).

Most of the people prefer maize to grow in the farm because the return from maize is more in comparison to the labor to cultivate them. Other crops such as Wheat (*Triticum aestivum*), Rice (*Oryza sativa*), Potato (*Solanum tuberosum*) and Millet (*Pennisetum glaucum*) are also important crops in the area. But they need more labor so they are less preferred. Maize is one of the most important crops for the livelihood in Asia. So raiding of maize results to develop negative attitudes towards wildlife (as cited in (Warren et al. 2007) Mishra 1982).

During the field survey it was observed that choice of crops is a sort of compromise between the costs and benefits associated with crop type. The factors such as labor requirements for cultivation, harvesting, storage, food preparation and food preferences and traditions affects the type of crop grown (Hill 1997).

Rhesus macaques are not clever only in choosing the best crops for their benefit but also intelligent to choose the best site where they can get more food resources over a long period of time. The more and less crop raiding in the two studied areas can be a good example for this. Jhor Mahankal is the part of Shivapuri forest which is a quite place. Since this Rhesus macaque population thrives in the disturbed areas they have more activities in this part. Trishuli highway passes through Goldhunga. It has a Army Barack which protects the National Park as well as a Nagarjun Palace where the Ex-King of Nepal Gyanendra Bikram Shah resides with his family. Human activities are higher in the Goldhunga area in comparison to Jhor Mahankal area.



#### **4.4 Possible effects from persistent conflicts**

Persistent conflict with human-wildlife may have significant impacts on natural ecosystems and may cause even local extinction of wildlife populations (Woodroffe et al. 2005). The Rhesus macaques are injuring people and they are also being killed and injured by people. Attractions and love towards the nature and natural resources help in the protection of nature. Long term conflicts may enhance animosity and fear among people. The loss of lives and food are not the only consequences. The antagonism between people and animals makes wildlife conservation efforts more difficult especially when the species is not protected by Government.

Crop damage by wildlife has caused food insufficiency and seasonal outmigration in the Shivapuri-Nagarjun National Park. It has been reported that more than 400Ha of land was abandoned in this area to minimize the crop loss (Seeland 2000). During the survey some farms were seen barren to lessen the crop raiding loss.

The cascade effect may be another long-term effect of conflicts with humans. The wild animals are interrelated in the ecosystem and loss of one species may cause secondary extinctions. The behavior ecology of the Rhesus macaque is important to study.

## 5. Conclusion

This study confirms that crop raiding is a foraging strategy of the Rhesus macaques which give them direct and indirect benefits. They develop well in disturbed areas and are very clever to choose the disturbed sites to get the more food with less effort. Since the distance from the national park area does not affect the crop raiding pattern changing cropping system can be better option.

The Rhesus macaque is a pest animal which needs fair management by the government. Their persecution will never be a good idea for better management of this species.

The mixed crop system instead of monoculture can be advised as preventive measures. But it cannot be advised to change their cropping system at once. Maize is one of the important crops for sustaining their life but they can rotate their crop system with the least raided crops.

The management solutions should target the local people especially farmers. A bottom-up approach should be practiced to get the desired output for conservation. The local people should always be included as a part of nature and the benefit from the national park should also be shared with local people to minimize the conflict. The other important thing is to deter Rhesus macaques from the farms so the garbage which is mostly attracting these animal should be removed. The waste dumping sites should be made far from their home range area.

Conditioned taste aversion is also a good method but precaution should be made before using the chemicals. Long term effects of the chemicals should be known before it is used. Since these animals are very clever if any individual became sick the remaining individuals avoid eating that food.

Translocation of problematic individuals is good but the habitat study and population study should be done before it.

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6. Is there change in crop raiding pattern in comparison to last year?  
a) Yes b) No
7. Which season they raid most?  
a).....b).....c).....d).....
8. Are you using any controlling methods to reduce the impact of Rhesus macaque?  
a) Yes b) No
9. What are they?  
a).....b).....c).....d).....

**C. Information on Attitudes**

10. Do you like to have Rhesus macaque in your surrounding?  
a) Yes b) No
11. What are the reasons to like Rhesus macaques in your surroundings?  
a) .....b).....c).....d).....
12. If you don't like what are the reasons to dislike?  
a).....b).....c).....d).....
13. What are your suggestions to protect these animals?  
a) Awareness among people b) Maintaining food quality of these animals in their habitat  
c) Making fences along farms d) Planting the crops which are less likely to be raided e)  
others.....
14. Have you killed Rhesus macaque while chasing them unintentionally?  
a) Yes b) No
15. Is there any injury to Rhesus macaque while chasing?  
a) Yes b) No
16. If yes how did you kill the Rhesus macaque?  
a) .....b).....c).....d).....
17. Who should be responsible for paying the crop loss of your farms?  
a) .....b).....c).....d).....
18. What are the other causes of conflict besides crop raiding?  
a) Snatching things from people b) Beating people c) Aggressive nature d) Any others
19. Have you observed any change in the Rhesus macaque behavior since last years?

a) Yes b) No

20. If yes please specify. a).....b).....c).....d).....

21. Have you observed any change in Rhesus macaque population in last few years?

a) Decrease b) Increase c) Don't know

21. Other comments

Thanks for your Time. Have a good time ahead.