International Journal of Zoology Studies
ISSN: 2455-7269
Impact Factor: RJIF 5.14
www.zoologyjournals.com
Volume 2; Issue 6; November 2017; Page No. 157-160

Agriculture crop damage by antelope (*Boselaphus tragocamelus*) and management strategies: Challenges in India

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Abstract
In India, problems associated with locally overabundant wildlife species have emerged as important management issues for reason of some species losing their natural habitat and adapting themselves to the man-altered situation. Crop-raiding by locally overabundant populations of nilgai antelopes (*Boselaphus tragocamelus*) has been widely reported in many parts of the country. Due to prolonged breeding activity and lacks of potential predators, numbers of nilgai have increased considerably and become locally overabundant in the states of Gujarat, Uttar Pradesh, Haryana, Punjab, Rajasthan, Madhya Pradesh and Delhi. The extent of human-nilgai conflict varied from place to place within these states. Nilgai were found to be capable of causing extensive damage to most agricultural crops. Damage to wheat (*Triticum aestivum*), gram (*Cicer arietinum*) and mustard (*Brassica campestris*) crops was caused not only by foraging but also through trampling, resting in field and daily movement of the animals. In low density nilgai areas, losses to wheat, gram and moong (*Phaseolus mungo*) crops were 20-30%, 40-55% and 40- 45%, respectively. Damage to guar (*Cyamopsis tetragonoloba*) and cotton (*Gossypium arboretum*) was 20-35% and 25-40%, respectively. Whereas in high density nilgai areas, damage to wheat, gram and moong was 35-60%, 50-70% and 45-60%, respectively. Mustard was seldom eaten by nilgai but it was damaged by trampling. There were also increased incidences of road mishaps (7-12 cases/state/year) due to vehicular collisions. Though people considered nilgai as a sacred animal, conflict between nilgai and farmers is on the increase, and which is adversely affecting the conservation ideals. Options for damage control and managing nilgai populations are available but each of them has their advantages and limitations. Possible management strategies to reduce crop damage are suggested.

Keywords: *boselaphus tragocamelus*, agricultural crops, damage, road mishaps, mitigation strategies

Introduction
Agricultural lands close to protected areas (PAs) often face crop raiding by wild herbivores, which can be a serious problem for farmers whose livelihoods depend on agricultural produce [1–4]. In order to avoid economic loss, farmers apply a range of protective measures. They include manual guarding, various types of fences, trenches and other devices [5–13]. However, these measures often come with high associated costs [14] and risks [11, 15–19]. The traditional fences are made using wooden poles and thorny branches lopped from nearby forests causing substantial damage to the forest. Destructive measures such as traps can kill or injure animals. Highly sophisticated means such as electric fences are expensive and need continued maintenance [14, 20]. Although a number of measures have been developed and shown to be effective on an experimental scale, there are reasons why they achieve limited success when employed on a wider spatial scale.

In India, problems associated with locally overabundant wildlife species have emerged as important management issues for reason of some species losing their natural habitat and adapting themselves to the man-altered situation. Crop-raiding by locally overabundant populations of nilgai (*Boselaphus tragocamelus*) has been widely reported in many parts of the country. Although people considered nilgai as a sacred animal, conflict between nilgai and farmers is on the increase, which is adversely affecting the conservation ideals.

In India, after the introduction of the Wildlife Protection Act (1972) and through associated management actions, the populations of many wildlife species have increased considerably, and a few of them have decidedly become locally overabundant. Due to disparate and often incompatible land use practices, these species have become ecological dislocates. Those that have been successful in adjusting to the man-altered habitats have thrived, and in many places such species have become serious pests of agricultural crops and are competing for resource utilization with domestic stock [21, 22, 23]. Nilgai, an antelope, is afforded holy and sacred rites by Hindus, and has rapidly grown in numbers outside protected areas. Agricultural crop damage by nilgai has been widely reported from almost all corners of India [25, 26, 27, 28]. Rural societies existing on subsistence agriculture can ill afford to have their crops raided by nilgai. Realizing the seriousness of the problem, poor farmers are now becoming increasingly intolerant to damage to their crops. Some have developed outright hostile attitudes toward the animals. It has now become important that administrators and wildlife managers take the initiative to actively control the wildlife damage to mitigate this problem, which is also in the larger conservation interest. During 2006-2010, extensive survey work was conducted in different states, and information was collected on the occurrence and abundance of nilgai, and on their habitat and crop depredation patterns in the affected areas.

Results and Discussion

Nilgai is a highly adaptive antelope. Nilgai was recorded in 114 protected areas in 16 states, namely, Andhra Pradesh, Bihar, Chhattisgarh, Gujarat, Haryana, Himachal Pradesh, Jammu and Kashmir, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Uttarakhand, Uttar Pradesh, Jharkhand and West Bengal in the country. Out of these, Bihar, Uttar Pradesh, Rajasthan, Gujarat, Haryana, Punjab, Madhya Pradesh and Uttarakhand states have an estimated population of 5,500, 254,449, 20,974, 97,004, 41,434, 10,312, 60,677 and 7,728 animals, respectively, and they are the worst affected. They occur in human dominated landscapes and crop fields outside protected areas. Nilgai populations have increased considerably due to prolonged breeding activity and a high rate of multiple births and lack of potential predators. They have become locally overabundant in these states, thereby causing serious problems which include damage to crops, economic losses and increased incidence of road mishaps due to vehicular collisions. Nilgai caused extensive damage to most agricultural crops. Naturally diurnal, nilgai raid crops after dusk. Damage to wheat (*Triticum aestivum*), gram (*Cicer arietinum*) and mustard (*Brassica campestris*) crops was caused not only by foraging but also due to trampling of the crop during resting and movements of the animals. In low density nilgai areas, losses to wheat, gram and moong (*Phaseolus mungo*) crops were 20-30%, 40-55% and 40-45%, respectively. Damage to guar (*Cyamopsis tetragonoloba*) and cotton (*Gossypium arboretum*) was 20-35% and 25-40%, respectively. Whereas in high density nilgai areas, damage to wheat, gram and moong was 35-60%, 50-70% and 45-60%, respectively. Mustard was seldom eaten by nilgai but it was damaged by trampling. The extent of crop damage varied considerable, depending upon the animal numbers and crop protection strategy followed in the area. Mustard and cotton are grown extensively in the affected region and were found to provide excellent hiding cover to these animals. There were also increased incidences of road mishaps due to vehicular collisions in these states. The accidents ranged from 7 to 12 cases per State every year.

Recommendations

Damage Protection

Crop Protection

For rural people in the nilgai affected areas, effective crop protection strategies are necessary. Any form of fencing is little used. Brushwood fence used in some places is effective against cattle only but it rarely restricts nilgai. The most common protection strategy for farmers is to guard their fields by remaining vigilant during the crop season. Constraints in Damage Control A major constraint on control is that the nilgai is an animal of considerable religious reverence. Most people in the affected area are Hindus. Sirsa and Hisar districts are dominated by Bishnoi Hindu communities. They all are strongly against any proposal for culling of nilgai or capturing them with physical force. However, in spite of all this, most farmers now seem to have reached their tolerance threshold.

Possible Management Strategies

Understanding animal damage problems and their control is the prerequisite of resource management in most man altered habitats to which wildlife will adapt and often quite successfully [30]. To plan any strategy to mitigate the crop damage problem, it is essential to have adequate information on the population and eco-behavioural aspects of problem animals, the particulars of agricultural lands, their distribution, crops, and the impact on local economy. This information was gathered in a rapid survey of a few problem areas. Earlier, the following strategies for control of nilgai damage problems have been suggested [29]. Selective reduction of nilgai populations would normally be the logical control strategy. Although hunting of these animals is legally banned but realizing the seriousness of the damage problem, this state-wide ban needs to be reviewed. Areas most seriously affected by the problem where such trials would be locally acceptable are required to be identified and then culling of the animals may be carried out either by experts from wildlife staff or hunters hired by the forest department. Out of the total number of the animals in an area, at least 45% of the adult females and 20% of the adult males need to be culled if the overall population is to be maintained at low levels. The monitoring of the population should then be continued to arrive at effective rates of culling since population subjected to low level by hunting typically breed at a higher rate [31]. But overall the objective of hunting is to keep the animal numbers within reasonable limits [32].

Confining in Corrals

To segregate sizable populations of nilgai, the need for enclosing the animals in certain selected forest patches identified as their known habitats, is proposed. Further experiments with chemical contraception of the fenced animals in order to reduce reproduction rate, and ultimately their numbers, are required. Though in problem areas of Haryana not much of forest land is available, it will hardly be possible to fence in the present nilgai populations on a sustainable basis. However, experimental trials to fence in these animals in the refuge areas, e.g., Nahar RF, at high densities and provide them with feed from outside need to be tried. For driving the animals into fenced areas, the law of diminishing returns will strongly operate with each repeat operation. Erection of fence and enclosing nilgai inside will need to be a protracted process, beginning with fixing fence posts along the perimeter with least disturbance to the animals while they use the area as a daytime refuge, enabling the animals to get used to the sight and sounds of humans. Erection of the fence should gradually progress around the key use areas, attempting to enclose a high percentage of the site population. Concurrently, food must continue to be added as a lure. The closing of fence is critical and should be done when the animals remain least active. Chain-link fence with at least 3- m height will be ideal. After confining nilgai inside the fence, the animals will have to be allowed time to adjust their numbers and resources inside the fence. Mortality due to stress is to be expected. The situation inside the fence and

status of outside populations must be monitored. Simultaneously, experiments on suppression of breeding activity of the fenced animals essentially need to be tried.

Fencing Agricultural Areas

The cost of providing protection to crops by barriers such as trenches, barbed wire and chain-link fences is prohibitive. However, power fencing, which would be cheapest and effective, can be tried. Although it may be possible to protect certain valuable crops in this way, such measures may export the problems to other unfenced crop areas. Furthermore, the area has considerable domestic stock and it may not be easy to exclude the wild while allowing domestic grazers. However, trials on use of this strategy are needed with a follow-up of monitoring the results.

Management Trials and Results

Based on above suggested methods, the forest department started an experimental trial in Nahar area of Haryana in early 1988. At this time, the estimated populations of nilgai in Nahar area, as per the information of the forest department and from the local people, were over 500 and 240, respectively. Chain-link fencing along the perimeter of a RF patch of 200 ha, which is extensively used by the animals, is in progress with the aim of confining them within the fence. By now, the fencing has been completed only on two sides of the quadrangular patch. Confining large numbers of these animals within the fence is expected not only to reduce the crop damage but the fence so constructed will also act as an exclosure for the remnant outside population. Restricting the animals from entering into the RF areas this way will cause continuous stress on them, and this is likely to result in depressing the breeding rate and adversely affect survivorship. During the course of the above operation, the animals were found seeking no other place for shelter other than crop fields or other negligible RF land, where they remained under obvious stress due to farmers chasing them out of crop areas or killing attacks of predatory dogs kept by the agriculturists. To keep nilgai out of crop fields, agriculturists illegally used naked electric wire, carrying 220 V current, all around their cultivation areas, especially in Nahar village. Generally, the animals come out of RFs through certain strategic points along the boundaries in the evenings and at night and tend to negotiate the barrier to enter into the crop fields. As the animals come in contact with the electric wire, they receive a severe electric shock. These animals are found either deformed or dead in the fields or RFs. Many such deaths were recorded in the recent past. This practice is illegal and highly dangerous to human beings. It will also create a severe adverse public reaction to the application of power fence technology, not only in Haryana but also elsewhere in the country. It seems possible that by the use of the above strategies, the pest populations and problems are likely to be markedly reduced in near future. At present, the number of nilgai in this area is estimated to be only about 60. It appears to be the consequence of the fence building activity that has temporarily displaced the on, on the- spot populations. It remains to be seen as to what happens once a large number of animals are successfully sequestered. The strategies adopted by the forest department and local people must be viewed as a trial. Although situations under which a particular method is suitable for application will differ, it will help in developing an approach to solve the problem and also enable comparisons between approaches to judge suitability, where comparisons can be made on an even footing. It is also to be noted that success is likely to be limited as a short-term gain. Periodic culling appears to be the only long-term solution. Such a solution as has been cited may not be popular, however, or acceptable by the public.

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