



The Indian Antelope *Nilgai* (*Boselaphus tragocamelus*) Appropriate Contender for Domestication could add in Human Society

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Authors' contributions

This work was carried out in collaboration among all authors. Author SP designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors RKS and AJ managed the analyses of the study. Author RA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The domestication of animals was part of a major transformation in the way of life of an increasing number of human societies with deep social and spiritual changes. In the present study, we report about utility of *Nilgai* and the values of its products and how it can add variety in our diet. Domestication of *Nilgai* may prove as an outstanding diet (veal and juveniles) for human and domesticated carnivores it may be the most important achievements that man-made in his cultural history. It is very useful and has many kinds of beneficial mutualism with man exists. We also prerequisite to reconnoiter biological functions, importance, and distinctiveness of products viz milk, meat, leather and body parts such as skin, teeth, nail and other product in addition to transportation and export, because of their size and powerful appearance. The meat of *Nilgai* is said to be lighter and milder flavored than that of blackbuck meat. A domesticated animal such as livestock plays a

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vital role in diversified farming systems because food and recycling of nutrients through the farm are well proven. *Nilgai* appears to have different color which occurs during the developmental stage, like a fawn, juveniles and adults. Few *Nilgai* showed some docility behavior in nature subsequently that sighs of taming towards domestication. *Nilgai* may prove a higher status than other domestic animals when it comes to success in domestication. The *Nilgai* dwelling near the human habitation in proximity to a close distance in anthropogenic and share with its habitat and graze food and fodders with domestic herbivore mammals like goat, buffalos' and cow in the periphery of the village's areas. The domestication of *Nilgai* corresponds to a pivotal change in history not only of humanity but also of the biosphere.

Keywords: *Wildlife; mammal; blue-bull; taming; blue-buck; docility.*

1. INTRODUCTION

The domestication of cattle and others species of the tribal Bovini has contributed significantly with and played a key role in the development of human civilization [1]. In the present time the Indian *Nilgai* (*Boselaphus tragocamelus* Pallas) is one of the most discussed wild antelope and burning issues in the agrarian society of India. During the last three decades increasing uncontrollable human population, anthropogenic activities like industrialization and urbanization are rapidly replacing natural resources, habitat, degradation of terrestrial and aquatic ecosystems, and decreasing free space for wild mammals that have been exposed to serious stress which threatens their stability [2,3]. Today, agriculture is responsible for the destruction or modification of nearly 40% of the land surface [4]. All the wild species of mammals on the earth have some exclusive ecological niche & function. *Nilgai* is one of the most important elegant species of antelope groups. The Asiatic white-footed antelope, *B. tragocamelus* is the largest bovid and also a biggest antelope in the world, which is confined only to the Indian subcontinent [5,6,7]. The availability of *Nilgai* is reported in the sixteen states of India which is commonly known as '*Nilgai*' in English "Blue Bull" locally named Ghandroze/ Nilghor in Eastern Uttar Pradesh (UP), Haryana and (MP), Rozra. Bihar has become a major threat to the rural crop production processes in the entire Uttar Pradesh, Western part of Bengal, Madhya Pradesh (MP), Rajasthan, Maharashtra, Gujarat, Northern part of Karnataka, Punjab and Haryana [8,9]. Undoubtedly in the present time, *Nilgai* has posed a serious challenge to agricultural society and agricultural production in the entire Indian nation. But it is also a fact and positive sign that nilgai is surviving and breeding the changing

environment condition, indicates more suitable for this extreme condition and it may be used as farm animal and adds in human society after a detailed study of utility etc. It is roughly estimated, reported, that over five lakhs of *Nilgais* were found only in six north Indian states shows that possessions generate a vibrant association in the determination of the human. Many researchers like [10,11,12] reported and suspected that within a few decades we might lose most of the highly valuable farm animals' genetic resources that humans have gradually selected over the past millennia. According to [13,14] reported that the possible domestication occurred when humans were faced a specific need and requirement. *Nilgai* has been a subject of significant attraction, attention and researchable issues all over the Indian sub-continent.

In this context of background, we assessed for making an effort to report the importance & utility of *Nilgai* for domestication and may add in human society, who in turn successfully adapted in such type of extreme climate in an open unprotected area of Bihar, India.

2. METHODOLOGY

The number of Kishan Chaupals was attained in different blocks of the district Buxar, Bihar. Many surveys were also executed under state non-plan project in different districts of Bihar state by the first author. During the tenure of this visit's *Nilgai* were noticed and encountered many times and subsequently discussed with farmers regarding the availability of nilgai in the different ecological zone in Bihar Fig. 1. The observation of these wild animals was made very carefully from a close distance and behavior of the animal was also observed according to [15,16].

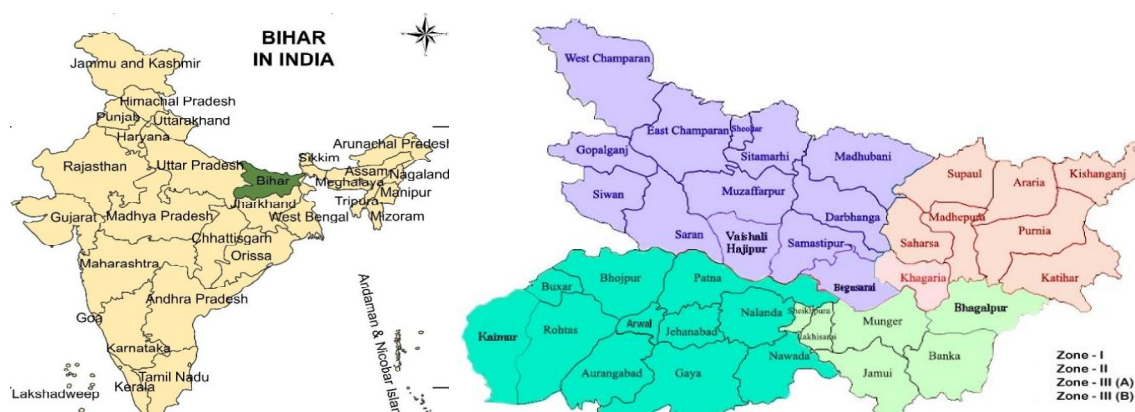


Fig. 1. Map of the study area in District Buxar, Bihar, India

Some photographs were also taken and some necessary information was also collected from the past history and attitudes of the people towards this stylish antelope and from the villagers living near in the fringe area of South Bihar. The present investigation was carried out on the availability and the abundance of Indian nilgai in South Bihar from January 2018 to December 2019. The study area falls under the agroclimatic Zone III A&B, where Zone III B (covering 11 districts like Buxar, Kaimur, Rohtas, Aurangabad, Arwal, Bhojpur, Jehanabad, Gaya, Nawada, Nalanda and Patna) is characterized by typically hot and heavy rain and also characterized by extreme high and low temperature during summer and winter respectively.

3. RESULTS AND DISCUSSION

Wildlife possessions create a vibrant association in the persistence of the human species and have been a subject of considerable attraction, attention and researchable issues all over the world. Some scientists even consider that truly wild nature (pristine zones from human impacts) does no larger exist on earth [17]. The anthropogenic pressure in response to climate change has brought significant change in fauna and flora [18]. [19] proposed to assign the term 'Anthropocene' to the present geological epoch, supplementing the Holocene, one human has become an important geochemical force and perhaps the dominant ecological force on the planet. The Anthropocene era could be said to have started in the late eighteenth century [19]. In the present scenario of climate changes, the agroclimatic condition kept on uncongenial and the forest became very thin. Over these Shahabad (Bhojpur, Rohtas, Kaimur and Buxar)

areas the ambient temperature rises up to 45°C during summer (May-June) & winter starts towards the middle of October and during January-February, temperature drip down to 4°C reported by [20]. The *Nilgai* have been considered a pest in several north Indian states as they ravage crop fields and cause considerable damage [21]. The many Indian states already proposed and some are declared this graceful wild antelope animal as vermin and ordered to kill them in favors of farmers. As per record total 2,228 numbers of *Nilgai* were killed by the professional shooter during 2017-2018 in different districts of Bihar [22,23], details are presented in Table 1.

3.1 Why the *Nilgai* Isn't the Problem

Most of the Indian states are facing this situation today that the wild animal (*Nilgai*) becoming the problem. Our recent study reports reported aimed at its habitat loss, deforestation and developmental work like industrialization and urbanization has been driving and forced *Nilgai* into the crop fields and human dwellings in search of food in taming condition [24]. For instance, about 7 to 11 million Km² of forest have been lost in the past 300 years due to land use activities, primarily for agricultural expansion and timber extraction [4]. Another region is the declining population of predators such as tigers and leopards leads to a consequential rise in the population of *Nilgai*. An unfavorable condition like natural calamities such as drought affects human beings equally feasible in the case with wild animals like *Nilgai* also. Similarly, drought dries up the availability of food for foraging driving wild animals into nearby crop fields and human habitat dwellings in search of food and later develop a two-way partnership with humans

[24,25]. Climate has played a major role in shaping the human culture and in turn domestication of plants and animals are also affected by the same cause that the men exploited this situation to his favor and thereafter started domestication, as well [26].

3.2 Need to Understand Population Dynamics

The time has arrived for a nation-wide policy framework to manage and to overcome human-nilgai conflict. Scientific management of *Nilgai* should necessarily involve population control. In the mean while a member of research has gone into this thematic area before we can reproductively control the population of *Nilgai*. First, we start with a better scientific management policy for *Nilgai* that must be adapted to the population dynamics of the wild animal and be region-specific. So, unless we study the long-term population dynamics of wild animals, we cannot decide whether culling could solve the problem of conflict or not. The problem might be something completely different than population rise.

3.3 Changing Behaviors and Habitats

The *Nilgai* are adapted for survival on the open agricultural field and prefer areas like short bushes and scattered trees, but nowadays from two or three decades they are found in a

common field and near the human habitation, villages areas also. The Indian *Nilgai* was protected under schedule III of the Wildlife (Protection) Act, 1972, and Delhi honored it as their state animal. *Nilgai* is also categorized as an animal of "Least Concern" under the International Union for the Conservation of Nature and Natural Resources (IUNC), [14]. The *Nilgai* is one of the most stylish antelope species in India. It appears in different colors during its growth and developmental period of different stages like fawn, juveniles and adult. It is also reported as being a fast along with swift-moving runner in nature and much more diurnal in its habits than a deer. [27] suggested that *Nilgai* exhibits substantial behavioral plasticity in response to different nature and levels of risks faced in the habitats. [28] reported behaviour of wild animals is probably the first to have been modified during domestication. In the changing scenario of a demographic and ecological niche regarding present stress situation, its (*Nilgai*) behavior has also been changed and it started moving for food near human habitation during the dusk period and feed along the night and returning come back early morning to the dwelling same space [23].

The Indian *Nilgai* prefer to eat the green and fresh vegetation and is also found of some crops as more favourite for *Nilgai* e.g. pulses, millet (*Panicum miliaceum*), maize (*Zea mays*), sugarcane (*Saccharum officinarum*), even tender

Table 1. Impact of *Nilgai* (*Boselaphus tragocamelus*) in six northern states of India

Sl. no	State name	Impact
1	Bihar	<i>Nilgai</i> is found in most of the districts of Bihar but the maximum crop damage has been reported in the different district like Kaimur, Buxar, Bhojpur, Vaishali, East Champaran Supaul, Nalanda and Patna. The Govt. of Bihar declared <i>Nilgai</i> as a Vermin in 2015, and over 2828 numbers of <i>Nilgai</i> were killed during 2017-2018
2	Uttar Pradesh	In Uttar Pradesh, its population was reported to the turn of 2.3 lakh <i>Nilgais</i> and it accounts for India's largest population. Attempts to cull it since 2013 but have failed. There is already a huge black market for <i>Nilgai</i> body parts such as skin, teeth, nails, and meat.
3	Madhya Pradesh	This state was also severely affected by nilgai; 3, 278 cases of crop damage were reported between 2009-13, and Rs 1.2 crore was paid in compensation. The name was changed to Rozra for allowing them to be killed by the state govt. (India Today, 20 th June 2016).
4	Maharashtra	Maharashtra has also reported crop damage by the <i>Nilgai</i> and the govt. has allowed the farmers & licensed firearm holders to kill <i>Nilgai</i> .
5	Rajasthan	State considering shooting them with contraceptive darts
6	Haryana	A large average of crop damage was reported in the different district like Sirsa, Hissar, Bhiwani, Rohtak and Mahendragadh. The State has proposed to the changing name to Rozra with permission for its killing.



a. Juveniles *Nilgai* in urban areas

b. Veal *Nilgai* grazing cultivated grass



c. *Nilgai* grazing in HCBF, Dumraon

d. *Nilgai* grazing with domestic animal

Fig. 2. a.b.c.d. *Nilgai* in different conditions and locations

leaves of paddy (*Oryza sativa*) and wheat (*Triticum aestivum*), various vegetable crops like cabbage (*Brassica oleracea*), cauliflower (*Brassica oleracea var. botrytis*), spinach (*Spinacia oleracea*), beans (*Phaseolus vulgaris*), lady's finger (*Abelmoschus esculentus*), brinjal (*Solanum melongena*), cucumber (*Cucumis sativus*), pumpkin (*Cucurbita sp*), gourd (*Lagenaria siceraria*), muskmelon (*Cucumis melo*). During the course of study, *Nilgai* underwent considerable change and share habitat with blackbuck and domestic animals like cow, buffalos, goats and others. The most important changes were observed like their appearance can be noticed in their attractive and glorious colour and size with special reference to females & juveniles, Fig. 2. a.b.c.& d. Docility behavior were reported regarding feeding pattern shows that the adult females graze with juveniles and dwelling near the human habitation in proximity of in a close distance in anthropogenic

environment [24]. It also grazes and share food and fodders with domestic herbivores mammals like cow, goat, and buffalo in periphery of village areas. [29] reported that the *Nilgai* can withheld tolerable interference by others livestock's and more importantly the degradation of vegetation caused in its habitat was found better than deer. [30,31] reported regarding behavioral changes shared by all domestics, is their's tolerance of proximity to people.

3.4 Importance and Status

Entire herbivore animals are more or less protagonists taking part in agricultural systems. Domesticated animals such as livestock also play a vital role in diversified farming systems, because their products become food and other value-added produces and recycling of nutrients through the farm preparation as well. The history of domestication is uncertain and dates back to

thousands of years with human civilization. Almost all the world's domestic animals originated in Asia. As per the record, only 20 large-sized wild animals in the world have been domesticated to provide food leaving almost more than 200 species of large herbivore animals which have not been domesticated till now [32]. Domestication began started with goat and sheep in the near East and what is now Iraq soon after the end of the last ice Age and it was well established by 7000 BC. Over the next few thousand years the process continued, till 2000 BC, the details are presented in Table 2.

During this stipulated period all the main modern domestic species except deer were established <http://arcaeological.about.com>. *Nilgai* is wild animal, attacking human habitation only at the cost of human's interact i.e., encroachment areas of wildlife for developing their own habitat. As a result, it has been causing huge economic damage of the poor's farmers agricultural field of the society. It is fact that most of the people of Bihar are dependent on agriculture. Out of several kinds of wild animals present outside the protected area, one animal blue bull has been destroying agricultural crops of the people on large scale and has become a menace [22,33]. While in Bihar, blue bull has been declared as

vermin and allowing them to shoot for some period. Biological steadiness merely cannot be reestablished through the barrel of a gun. The killing of wildlife causes tremendous suffering and opens the door to the illegal wildlife trade. There is already huge black market for *Nilgai* body parts such as skin, teeth nail and meat in India especially in Uttar Pradesh [22].

India, is already suffering from serious effects of climate change especially global warming alter the rainfall pattern and droughts. These all factors certainly hurt farmers livelihood first. Focusing on long term human solutions to the conflict as we humans have created the situation with animals by stealing their homes. It now needs focus on protecting what's left of the animals; theirs natural homes also it will ultimately benefit farmers and all of us. Silviculture-based cropping system help manage the earth's climate and their destruction by released restricted carbon into the atmosphere contributing to the eco-friendly climate and also regulate rainfall. Due to growing population and area expansion in agriculture there increases many folds in the number of grazing livestock which leads realized us to focus on the development of projects through are putting fragmentation pressures on natural habitats and

Table 2. History of wild mammalian domestication in different period in world

S. N.	Wild mammal	Domesticated	Years (BC)	Country name	Purpose
1	Wolf or Jackal	Dog	18,000-10,000	East Africa	Pet, cohort
2	Wild Goat	Goat	9,000-8,000	Iran	Food, milk and clothing
3	Mouflon and Asiatic Urial	Sheep	10,000-8,000	Southwest Asia	Food, milk, wool and clothing
4	Wild boar	Pig	9,000-8,000	China	Food, milk, sport, and clothing
5	Auroach, long horn wild ox	Cattle	8,000-7500	India middle east, sub-Saharan Africa	Agriculture purpose, meat, leather and religious region
6	Wild horse	Horse	4,000-3,500	Eurasian steppes	Transportation and meat
7	Wild buffalo	Buffalo	3500-3000	India china	Agriculture purpose, Milk and meat.
8	Wild camel	Camel	4000-3500	Iran and Turkmenistan	Agriculture purpose and transportation
9	Wild elephant	Elephant	2500-2200	India	Transportation
10	Wild <i>Nilgai</i>	<i>Nilgai</i>	<i>Nilgai</i> is may be a promising candidate for domestication & could add variety to our diet		Agriculture, milk, meat, bioenergy, transportation and others

Source: <http://arcaeological.about.com>

Table 3. The Indian antelope *Nilgai* is an ideal candidate in many ways

Sl. no.	Reputation	Gorgeous
1	Large antelope	The large size reduces our harvesting & processing cost and tolerable interference with livestock's, degradation of vegetation in its habitat. Male slightly larger than female.
2	Exhibited social structure	Females and juveniles are always together. They live, graze and sit together in a group as its exhibited social bond. They also graze with domestic animals.
3	Quick growth rate	<i>Nilgai</i> becomes sexually mature by two years, this maturing rate compared to the human life span allows breeding intervention and makes the nilgai useful with an acceptable duration of caretaking.
4	Females and juveniles very prominent	Allows us to offer its meat at a very attractive price and it is very flexible in its requirements.
5	High reproductive rate	<i>Nilgai</i> produced regularly more than one offspring in a year and beneficial for income generation.
6	Much like veal	The meat has a mild pleasant flavor with a good texture & taste as well.
7	Extremely contain very low fat	Averaging well under extremely low fat 1 % for most of the cuts, it may be a promising endeavor and could add variety to our diet. (Kye, Russell, 1990)
8	Flexibility in diet and habitat tolerance	<i>Nilgai</i> having both browser & grazer. They prefer food like grasses, herbs and wooden plants. They do not drink water regularly even in summer, can survive for long period without water, it's comfortable for domestication.
9	The Generic name is <i>Boselaphus</i> combination of two-word Bos + elaphos	" <i>Bos</i> " come from Latin word means ('cow' or 'ox'), it also looks like cow. " <i>Elaphos</i> ", come from Greek word means (deer), some behavior is similar to that of deer special four horned antelope.
10	The specific name <i>tragocamelus</i> come from join of two Greek word tragos + kamelos	" <i>Tragos</i> " means (he-goat) and " <i>kamelos</i> " means (Camel), it is cleared that <i>Nilgai</i> having very nearest family to goat and camel also, so its meat and others body parts are very useful for human well-being in future.

also increasing the incidence of conflicts between wildlife and humans [34]. In view of the aforesaid context, it is felt and thought that there is an urgent exclusive program for well-being of farmers and improve the economies of farmers and minimize damage to both humans and wildlife.

The Indian *Nilgai* may be useful in various ways we prerequisite to reconnoiter their biological functions, importance and distinctiveness of added products viz-milk and flesh of nilgai body parts such as skin (hides), teeth, nail and meat as reported in Uttar Pradesh and their adjoining areas. Blue bull flesh is highly in demands in the foreign countries it may be exported after domestication and also add in the agrarian society. As a matter of fact, *Nilgai* is agricultural pest in India but it occurs rare in Nepal and Pakistan [35]. The major reason behind its decimation in these two countries and extinction

in Bangladesh are extensive hunting, deforestation and habitat degradation in the 20th century. [36] reported that *Nilgai* was not widely hunted until the 20th century when habitat degradation and poaching become extensive. [37 38,39] reported regarding the meat of *Nilgai* is said to be lighter and milder flavored than that of blackbuck meat. The Indian *Nilgai* has many qualities to recommend it for its domestication. *Nilgai* is both browser and grazer or mixed feeders, it prefers grasses and herbs, though they commonly eat woody plants in unfavorable condition [29]. The female *Nilgai* regularly produce more than one offspring and it is very flexible in its requirements. The white footed antelope may be ideal candidate for domestication and could add in agrarian society of India, details are presented in Table 3. Undoubtedly, most of the large herbivore's animals are virtuous to eat as socially and culturally restriction, so why do we twig through

cows, sheep and pig? Why not *Nilgai* domesticate? In present stress condition, it has been seen a dramatic improvement towards altering behavior in *Nilgai* with changing climatic and demographical present scenario in Bihar. *Nilgai* following commensal or prey pathways tends to possess more traits that make them promising candidates for domestication. [30] reported conversely species on directed pathways likely possess barriers to domestication that require more knowledge on the part of humans to overcome. There is very little knowledge about the characteristics and utility of this animal where detailed study on various issues could be utilized in future. This could make it a much better choice for farming than the red deer. The purpose of domestication of animals since ancient times was felt needed based on mutual benefits and symbiotic relationship. The provisions to allow wild / neglected animals to kill them can be misused and against the wild life protection act nationally and internationally. *Cervus elaphus*, the most highly regarded of the new domestic animals. [40] also reported regarding domestication corresponds to a pivotal change in the history not only of humanity but also of the biosphere.

4. CONCLUSION

All those above situations force us to think about its farming and *Nilgai* may be domestication for the purpose of uniqueness of its milk and meat and other bio-molecules for therapeutic use in export-oriented market and commerce. So, we need to explore their studies in the quantitative and qualitative parameters of their products well supported by their phenotypic & genotypic for proper utilization in future under an appropriate form of economic management. The Indian *Nilgai* may be promising candidate for domestication and could add in agrarian and human society and as series of several varieties to our diet.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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