Indigenous measures developed by farmers to curb the menace of blue bull
(*Boselaphus tragocamelus*) in district Rajsamand, Rajasthan, India

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Due to destruction of forest areas, herds of blue bulls (*nilgai*) have started attacking agricultural fields. Their habits are so destructive that they eat less and waste more. Killing of the animals is difficult due to social/religious sentiments and protection provided by government under Wildlife Protection Act, 1972 which has made killing of blue bulls a punishable offence. So, local farmers of district Rajsamand have searched out and tried certain unique innovative methods by using indigenous knowledge at their village level to curb this menace. The study revealed that the most common traditional methods prevalent in Rajsamand district of Rajasthan are- use of scarecrows locally known as *Odaka*, live fencing of Indian spurge tree locally known as *Thor* (*Euphorbia neriifolia* L.) and Velvet mesquite locally known as *Vilayati babul* [*Prosopis juliflora* (Sw.) DC.] around their field boundaries, beating bells in crop fields, use of animal excreta especially of blue bull excreta is a wonderful repellent for themselves, using mixture of donkeys excreta, cow urine and other waste like rotten vegetable leaves producing foul smell to allay blue bulls, use of crackers, use of forate insecticide granules and spray of phenyl solution as repellent and making fence of reels of shining tapes like video/audio tapes around the crops fields.

**Keywords:** Crop losses, Beating bells, Scare crows, *Thor*, Blue bull, *Vilayati babul*

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The state of Rajasthan, long recognized as an important region for endemic biodiversity. In recent years the number of wild animals started migrating to the agriculture fields due to degradation of forest cover and overgrazing in the forests and posing a great threat to crops¹. The major drivers of this change include food competition between wild and domestic cattle, uninterrupted tree cutting and overgrazing. With limited and declining forage available within the forest, herbivores become active in the night to feed and forage and are forced to come out of forests. For ages, wild animals survived in their natural habitat, but now they have shifted towards the populated areas in search of drinking water, food and shelter. Due to hunting and habitat destruction by human, they moved to the agriculture fields and villages. Growth in the numbers of blue bull and wild boar is due to their adaptation to feeding in crop fields around the sanctuaries². The major harm to the crops is reported mainly by the blue bulls. The blue bull (*Boselaphus tragocamelus* Pallas.) is biggest Asian antelope and is one of the most commonly seen wild animals of central and northern India (Fig. 1 A). Crop raids by blue bulls have been widely reported in all villages adjacent to the forests and even beyond it. Such raids do considerable damage to crops, vegetable fields and orchards, sometimes ruining an entire harvest in a single nightly event. Besides this direct loss, raids also cause indirect damage and loss through feeding upon fruiting trees, flowers which reduce later fruit production considerably³. The man and wildlife conflict is driven on the one hand by increased year round cropping in villages around the sanctuaries, but also by declining forage resources within⁴. Further, because of their short gestation period and high reproductive potential, the population of blue bulls has exceeded over carrying capacity of the natural habitats resulting in their migration to crop fields. Their huge population size started damaging the crops for filling their belly. This crop damage gives the farmers major monetary losses. The extent of crop damage has reached 50-70 % in the country. The study carried out at CCSHAU, Hisar explored that the blue bull has been damaging standing crops worth crores of rupees every year and loss caused to the standing crops in some areas was found to be as

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much as 50\%\textsuperscript{5}. Prospects for electrical fencing or other expensive and resource intensive solutions are poor. Killing of the animals is difficult due to social/religious sentiments treating it as cow (\textit{gai}), a sacred animal. The protection provided by government under Wildlife Protection Act, 1972, which has made killing of blue bulls a punishable offence\textsuperscript{1}. But due to heavy losses caused by the blue bulls, state governments are under pressure to change some provisions of the act and issue necessary permission to kill blue bulls as per the procedure laid down in the act. Loss of agriculture crops due to blue bull menace is very important and relevant as on today and needs, great attention particularly at policy level for making necessary changes in the Wildlife (Protection) Act, 1972 permitting culling of Blue bulls. The Chief Wildlife Warden or the authorised officer may, if he is satisfied that any wild animal specified in the Schedule II to IV has become dangerous to human life or to property (including standing crops on any land) or is so disabled or diseased as to beyond recovery, by order in writing and stating the reasons therefore, permit any person to hunt such animal or cause such animal to be hunted. Blue bull is categorized under Schedule IV of Wildlife (Protection) Act, 1972 where in Chief Wildlife Warden of the State can permit killing of the Blue bull\textsuperscript{6}. Some state government like Madhya Pradesh had permitted hunting of blue bulls causing damage to crops in 2000 after due permission from the local Sub Divisional Magistrate (SDM). To allow hunting, government has evoked Section 11 of Wildlife Protection Act which permits killing of animals if they pose any threat to the habitat or destroy crops. Himachal Pradesh government also has provisions to kill the blue bulls as per the procedure laid down in the act. Uttar Pradesh and Rajasthan have already permitted to kill blue bulls. The UP government has authorised district collectors to issue permits for killing. In Rajasthan, the powers are vested with the district forest officer to issue orders of permitting culling of Blue bulls but even then implementation is not satisfactory perhaps due to religious sentiments especially protest of \\'Vishnoi\' community, a sect of Hinduism, who has been fighting the authorities against any attempt to grant licenses to kill the animal. Like in one instance during 1996, the state government gave directions for authorizing forest officials in Jaipur district of Rajasthan to kill animals when they damage crops\textsuperscript{7}. In Gujarat state \textit{panchayats} are empowered for issuing killing permit\textsuperscript{1}

A participatory approach of conservation plan is needed for wildlife management\textsuperscript{2}. So, the local farmers of district Rajsamand have searched out and tried certain methods at their village level to curb this menace. Blue bulls have certain characteristic behaviour and habits which have been explored by local people to fight them. They are diurnal and tend to form single sex herds during breeding season. Both males and females mark their territory by defecating in fixed locations on open ground in piles building up to reach at least 3 m (9.8 ft) in diameter\textsuperscript{8}. They also possess scent glands on the legs and close to the feet, which they may use to scent mark their daily resting places. The present study tried to explore the locally developed methods by virtue of their indigenous knowledge at farmer’s level in course of time to manage the massive losses caused by the attack of large herds of blue bulls in crop fields in district Rajsamand. Generally they prefer different crops like maize, mustard, gram, chillies, cauliflower, cowpea, black gram, cabbage in the mature growth stage while wheat, barley, potato, radish and pumpkin in the early stages. On an average, an adult blue bull needs 14 kg of dry biomass of palatable tree species (420 kg per month)\textsuperscript{2}. The annual economic loss to each farmer is about Rs. 9,000 - 11,000 per year \textsuperscript{9}. The blue bull menace changed the cropping pattern both in \textit{kharif} as well as in \textit{rabi} season in the study area. The area of pulses, especially of green gram (\textit{Vigna radiata} L.) (896 ha in 2006 to 712 ha in 2011) and black gram (\textit{Vigna mungo} L.) (1332 ha in 2007 to 1268 ha in 2011) reduced and shifted towards growing of sorghum [\textit{Sorghum bicolour} (L.) Moench] (5636 ha in 2007 to 7207 ha in 2011) in \textit{kharif} season\textsuperscript{10}. Further, area of groundnut (\textit{Arachis hypogea} L.) (3281 ha in 2006 to 1788 ha in 2011) and cluster bean (\textit{Cyamopsis tetragonoloba} L.) (5482 ha in 2006 to 2753 in 2011) also reduced and changed to cotton (\textit{Gossypium hirsutum} L.) (1530 ha in 2006 to 6583 ha in 2011) cultivation due to blue bull menace more in groundnut and cluster bean. Similarly, gram (\textit{Cicer arietinum} L.) (1665 ha in 2006 to 931 ha in 2011) cultivation also reduced in \textit{rabi} season and changed to rocket (\textit{roquette}) locally known as \textit{taramira} [\textit{Eruca sativa} (Miller) Thell.] cultivation (207 ha in 2006 to 1082 ha in 2011)\textsuperscript{11}.

\textbf{Methodology}

Study was conducted in randomly selected 15 villages of Rajsamand district of Rajasthan, \textit{viz}.
Information on indigenous measures popularized among the farmers to curb the menace of blue bulls was collected from 15 villages and from each selected village, 10 well experienced/old farmers were randomly selected, contacted and interviewed to collect the primary information. Thus, total 150 farmers were interviewed from the district. Among the respondent farmers, 85 farmers (56.57%) were marginal having land holding up to 0.99 ha and 33 (22.00%) farmers were in small category with land holding up to 1.99 ha. Further, 21 farmers (14.00%), 9 farmers (6.00%) and 2 farmers (1.33%) having land holding up to 3.99, 9.99 and more than 9.99 ha were in the category of semi-medium, medium and large holding farmers among the respondents under this study (Table 1). Further, primary information was collected in consultation with Deputy Director of Agriculture, Assistant Director of Agriculture, Agriculture Officers, Assistant Agricultural Officers of the district and Agriculture Supervisors of respective villages. Participatory Rural Appraisal (PRA) technique was adopted to identify and collect information about the indigenous practices prevalent in the selected villages. Key informants were innovative farmers belonging to different socio-economic classes. Farmers, farm women and farm labour of different age groups were involved for information collection through group discussions (focus group technique) related to indigenous technologies. The present study tried to explore the locally developed methods at farmer’s level in course of time to manage the massive losses caused by the attack of large herds of blue bulls in crop fields in district Rajsamand.

Results and discussion

Farmers use a range of informal methods by virtue of their indigenous knowledge to protect their crop fields and orchards from wildlife. Indigenous knowledge is the accumulated knowledge, skills and technology of the local people, derived from the direct interaction of human beings and their environment. Indigenous measures to curb the menace of blue bull which developed as indigenous technological knowledge by farmers and prevailed in district Rajsamand of Rajasthan can be divided under two major heads, viz. the common protection strategies when farmer is not physically present in the crops fields especially during night hours.

Indigenous measures to curb the menace of blue bull

Extensive surveys, on-spot observations and discussions with elderly and experienced farmers have revealed that the following innovative locally tested methods have been adopted by the farmers of Rajsamand to get rid of blue bulls.

Indigenous measures to curb the menace of blue bull in the physical presence of farmers in the crops fields

The most commonly used crop protection strategy of local people is guarding their crops in the field day and night regularly in the crop season. This method is used by 60% of the farmers in the study area. 20% of farmers use gophan, a device to throw stones towards animals to chase them away from the fields. Few farmers (15%) use dogs for crop protection and to chase the wild animals. In certain cases, these dogs kill wild animals, in particular infants and juveniles. While the remaining 5% of farmers use dangerous methods like shotguns, potash bombs and high voltage electric current around farm fields. Many farmhouses use high voltage electric current around their crop fields and horticulture plantations. In all cases, wild animals are usually killed or seriously injured.

Indigenous measures to curb the menace of blue bull when farmer is not physically present in the crop fields especially during night hours

Use of shining tapes like video/audio tapes

This has been observed as a well established fact that blue bulls are afraid of shining materials which reflect light from far away. Due to this reason, farmers tie audio and video tapes roll all around 1the crop fields with wooden sticks. During daytime, the tapes glare due to scorching sunlight and in night, they reflect in dark. So, they prove to be a very successful technique to frighten the blue bulls (Fig.1 B).

Use of scarecrows

A very creative technique has been extensively used by the farmers locally, i.e. the use of scarecrows
commonly called as Odaka. This is a well known fact that birds and animals always fear of humans because of their shy nature. In a similar manner, blue bulls also try to isolate themselves from the human that is why; they try to enter the crop fields in absence of any care taker. And it’s very logical that a person can’t keep a watch of the field whole day round. So, a solution has been found out by the local farmers to this big problem of blue bulls. A scarecrow has been innovated which resembles humans and positioned in the middle of field which gives an impression to the blue bulls that any person is standing in the field. This illusion keeps blue bulls away from the fields. It’s very simple to make this structure. Two wooden sticks (5 ft x 2ft) are tied in criss cross manner (+). Then, this wooden framework is decorated by putting old clothes of farmers (dhoti, kurta, safa) or farm women (Lehenga, kurti, lugdi) over it. They are so beautifully dressed that it virtually gives an appearance of any farmer standing in the field. These live dummies have proven to be a very promising technique to keep blue bulls away (Fig. 1 C). At times, it has been observed that the whole family of a farmer has been erected at different places in the field to give an impression of many people working in the field together. Hence, this cheap and convenient method can be of immense use to curb the menace of blue bulls in the locality.

**Beating of bell**

These days wildlife protection is so much in discussion that government has made various stringent laws and acts to protect them. There is a complete ban of killing animals which has become a punishable offence. In such a scenario, killing of blue bulls is altogether impossible despite its destructive nature. To curb this menace, villagers have tried some local methods. Villagers hold meetings at village level and come up with an idea of using a locally made hanging bell to frighten the herds of blue bulls. In this method, a ghee/ oil tin is made hollow by removing lid, then a piece of stone or an iron ball is made to hang from the roof of the tin. This hanging stone is tied to a rope whose another end is under the control of the farmer resting far away. This structure is placed in the centre of the field on a long wooden stick of about 5-6 ft height. This tin bell is placed at 2-3 places in the field which are connected to each other in such a way by rope that if one bell is beaten, all other beat together automatically (Fig. 1D). Whenever some disturbance is felt from the blue bulls, the farmer starts beating the drum from his respective resting place and the blue bulls run away by fear. The interesting thing is that during night time, when the farmer sleeps away, he ties the rope around his waist or ankle so that whenever he moves while sleeping, the drum beats automatically. By voluntary consent in meeting, one person is assigned to give the duty of beating the bell. This duty is rotated among all the farmers everyday so as to frighten the herds of blue bulls from the fields. Because, blue bulls have a peculiar feature of moving and attacking in large herds and the sound of beating bell by this technique gives an impression of loud sound created by a group of people. This frightens the herds, and they remain away from the fields. In this way, through this innovation, the farmers are getting rid of the blue bulls very conveniently.

**Live fencing**

This is also a very cost effective locally adopted method of keeping blue bulls away. In earlier times, farmers were not having so many options to protect their boundaries of fields due to lack of new building materials and awareness. Also land holding size was very big. So, it is used to become a costly affair for fencing the whole area. From security point of view, local people have grown a local variety of cactus called thor, thuar, Danda thuhar in local language, common milk hedge and Indian spurge tree (Euphorbia neriifolia L.) in English belonging to family Euphorbiaceae. Also one more shrub
called vilayati or angaraji babul, vilayati khejra or vilayati kikar in local language and Velvet mesquite [Prosopis juliflora (Sw.) DC.] in English are planted around their field boundaries belonging to family Fabaceae. Thor is a very hardy and thorny bush which grows even without water, mostly planted by cutting in the month of May and June in summers (Fig. 1E). It is grown in a line along the boundary without any spacing. After attaining a good height of around 3-5 ft, fence becomes so strong and firm that not even a person can pass through. Hence, it can prove to be a natural method of fencing which doesn't require any cost.

Use of animal excreta
Since long, this has been observed by the farmers that the solution of blue bull excreta is a wonderful repellant for themselves. The herd of blue bull leaves good quantity of excreta wherever they rest which can be collected, made in a solution form with water and can be collected in a plastic can, then the solution is to be sprayed over the whole crop field. This has been observed that the obnoxious smell of the excreta solution repels other blue bulls to enter that area where it is present in the environment. It is believed that smell of excreta solution gives an impression to the herds of blue bull about presence of blue bulls already in the field. Due to which one herd doesn’t disturb the other herd. So, the smell of excreta solution acts as a repellant for the other blue bulls and can be considered as a good method of keeping away the blue bulls from crop fields. A mixture of donkey excreta, with cow urine and other wastes like rotten vegetable leaves can also be used which gives foul smell to allay blue bulls.

Use of fire cracker
Fire crackers are also extensively used to keep the blue bulls away from fields. As abrupt firing of crackers particularly during night time frightened the blue bulls due to the loud sound and sparkling light. But it is manpower involved method requiring extra efforts and creates pollution also with expenditure.

Use of Forate insecticide granules
Forate is a commonly used and easily available insecticide in the market in form of granules. It has been observed that the smell of Forate insecticide granules keeps away the blue bulls. The blue bulls dislike the fumes of this particular insecticide. So, farmers take a piece of old earthen pot in the shape of a saucer. Put forate granules in the saucer and place it at various points all around the crop field whenever the blue bulls try to enter the field, the particular smell will keep them away from getting inside the field for 10-15 days after spraying.

Spraying phenyl solution
Use of chemicals like phenyl solution is also very useful in keeping the blue bulls away. The obnoxious smell from spray of phenyl solution around the crops fields keeps blue bulls at bay of the crops fields and it is effective for more than 10 days after application.

Traditional significance of study to the farmers and some constructive recommendations
Since time immemorial wild animals especially blue bull menace has proven havoc in the agricultural and plantation yields which needs an urgent check and this can be controlled by personal farmer’s efforts. The rapid increase in the population of blue bulls (nilgai) in Rajasthan is a cause of concern to farmers and legislators alike. An elaborate study for changing the laws, short and long term integrated approach is required for the effective and sustainable control of blue bull. The present study suggested short and long term measures to control devastation caused by blue bull. The specific purpose is to spread the methods and techniques all over the country for benefiting agrarian populations all over. Under short term measures, biofencings of planting barriers, use of bio and chemical repellents and mechanical barriers, shining reflectants, and special mechanical sounds proved best in managing blue bull menace as they are cheap, free of cost, environment friendly and locally available. Under long term measures in pursuance of inconsistent complaints of farmers of crops losses by blue bulls have forced the legislators to think of excluding blue bull from Schedule 4 of the Wildlife Protection Act and incorporating in Schedule 5 which does not prohibit killing of the animal and considered blue bulls as vermin category and powers of killing them vested with Tehsildar and or up to Panchayat level functionaries. The Government can also plan to issue licenses to forests, the police and revenue officials to kill the animals which are creating menace. Further, detailed report of crop losses based on scientific study is required by framing pilot projects on “Participatory Blue Bull Management” model for assessing database of blue bull population.
Fig.—1(a) Glimpse of wild blue bulls, (b) Video tapes and cloth strips tied around the crop fields, (c) Different types of scare crow positioned in the field used by local farmers, (d) Pictorial representation of beating bell technique - farmer holding the string, picture of bell, (e) Pictorial view of cactus \textit{(Thor)} planted around the field boundary as a fence.
and extent of damage by expert group of Wild Life Institute of India and relevant departments. They can suggest measures to combat the menace of blue bulls and raise the local livelihood. Further, as a suggestive measure setting up of a sanctuary for blue bulls with detailed biomass study of the area with incentives to local affected farmers in the form of monetary compensation for crop damage suffered and growing alternate remunerative high value cash crops should be suggested by the scientists which are unpalatable to Blue Bulls.

Conclusion
The farmer is not getting the desired returns from agriculture due to various limiting factors including biotic and abiotic like weather conditions-temperature, rainfall, attack of insect pest and destruction by wild animals especially blue bulls. The various biotic and abiotic factors are uncontrollable but the menace of blue bulls can be controlled by personal farmer’s efforts. The crop damage and agricultural losses caused by blue bulls are experienced by local people all over the country. It becomes very urgent to control them. The rapid increase in the population of blue bulls (nilgai) in Rajasthan is a cause of concern to farmers and legislators alike. Multi-pronged, integrated approach is required by changing the existing laws, short and long term measures for the effective and sustainable control of blue bull. Under short term measures, use of indigenous techniques prevalent in Rajasthan like use of scare crows locally known as Odaka, live fencing of thorn (Euphorbia nerifolia L.) and vilayati babool [Prosopis juliflora (Sw.) DC.] around their field boundaries, beating bells in crop fields, use of animal excreta especially blue bull excreta is a wonderful repellent for themselves, use of mixture of donkey excreta with cow urine and other wastes like rotten vegetable leaves which produces foul smell to allay blue bulls, use of crackers, use of forate insecticide granules and spray of phenyl solution as repellent and making fence of reels of shining tapes like video/ audio tapes around the crop fields. Under long term measures, keeping in view the inconsistent complaints of farmers regarding destruction by blue bulls have forced the legislators to think of excluding the animal from Schedule 4 of the Wildlife Protection Act, which prohibits killing of blue bulls. The governments have decided to include blue bulls in Schedule 5 of the Wildlife Protection Act, which does not prohibit killing of the animal and considered blue bulls as vermin category like antelope and gave powers to Tehsildar and or up to Panchayat level of killing them. As a guide, detailed report of crop losses based on scientific study is required. Also there is a need for creation of database of blue bull population and conductance of pilot projects on “Participatory Blue Bull Management” model for assessing database of blue bull population and extent of damage by expert group of Wild Life Institute of India and relevant departments by suggesting measures to combat the menace of blue bulls and to raise the local livelihood. Further, as a suggestive measure setting up of a sanctuary for blue bulls with detailed biomass study of the area can be proposed. Also incentives should be provided to local affected farmers in the form of monetary compensation for crop damage suffered and alternate crops should be suggested by the scientists which are unpalatable to Blue Bulls. The Government can also plan to issue licenses to forests, the police and revenue officials to kill the animals which are creating menace.

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