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Impact of human-animal conflict on farming in and around the protected areas of Savanadurga (Magadi), Karnataka

Mohan I Naik, Basavadarshan AV, Boraiah B and Harsha HK

Abstract
Human-animal conflict is the most devastating issue in the edges of the protected areas, and crop losses and livestock losses are the resultants of it. A household questionnaire survey (2017-2019) of farmers on animal and human conflict in the villages around the Savanadurga protected areas of Magadi taluk, Ramanagara District, Karnataka State revealed that highest per cent of conflict responses recorded in villages surrounding the Savanadurga (12.9%), Sidde devara betta (10.3%), and Chiluru (10.0%) human inhabitant sites. Among the vertebrate's wild boar, monkeys, rodents, elephants, and birds expressed the conflict by crop damage and were more frequent. The maximum damage was recorded in banana (15.47-52.65%) followed by groundnut (15.64-48.76%), vegetables and fruits (8.21-36.78%), ragi (15.23-36.78%), red gram (7.45-23.32%), cowpea (2.3-10.56%). The damage and infestation were critical during the maturity, harvesting, and post-harvesting stages. Livestock was predated by the leopard, wild dog, jackal, and mongoose, and the predated animals were a cow, goat, sheep, and poultry birds. Erection of old color sarees around the crop, use of scarecrows, sounding through drums, F.M Radio as artificial acoustics, burning of crackers, use of a local dog, human guarding at night, use of local traps for rodents were the mitigating measures practiced by the farmers.

Keywords: Crop damage, human-animal conflict, livestock, vertebrates

1. Introduction
Human and wildlife conflict is widespread, and most interacted phenomenon faced among the conservationists and protected area managers today [20, 21]. Protected areas are part of vast ecosystems, and activities such as land-use changes in the unprotected area have an impact on ecosystem function of protected areas [12, 15]. Continued forest resource exploitation and conversion of forests and wetlands to agriculture result in a shrinking resource base in which the demand of resources between humans and wild animals overlap and competition for food, space, and water and creates tension among the conservation authorities [10, 13, 31]. Crop raiding, livestock predation, human and animal injury or death are the results of conflict [11] threatens the conservation of many wildlife species involved [26]. Its worldwide occurrence is most intense in developing countries where most of the population lives in rural areas and characterized by livelihoods centered on livestock holdings and agriculture [1, 8]. Crop raiding is a conflict between farmers and wildlife, which is more so along the boundaries of protected areas; due to the non-availability of preferred dietary items in the original habitat, the animals compelled to depend on crops for food and do enormous damage to the crops [25].

India has the rich diversity of flora and fauna in the semi-arid, western ghats, the Deccan peninsula, and Gangetic plains zones are facing the issue of conflict from a variety of species, in varying degrees. The major species involved in the conflict are primates, rodents, ungulates, antelope, wild boar, elephant, tiger, lion, and leopards [16]. About fifty species of vertebrates are involved in causing damage to horticultural crops in India [5]. Vertebrates such as birds, and mammals, cause damage to crops and which is leading to loss of human livelihood which has been vividly reported in various human inhabitant sites of India with rodents, birds and wild boars [6, 23], Nilgai, [7, 24] elephant, [30]. The extent of damage caused by different species of vertebrate pests depends on population density, cropping pattern, the extent of crop area, season, and stage of the crop [2]. With this background, Savanadurga (Magadi) protected area which is 48 km away from Bangalore metropolitan city with enriched forest wealth and healthy agricultural activities were selected to document the types of crops cultivated, animals involved in conflict, extent, and pattern of crop damage by animals and to document the

techniques practiced by local people to mitigate the conflict. In which it would help in understanding the extent of human-animal conflict faced by the farmers, to evolve the best mitigating measures, and establish the coexistence between humans and animals.

2. Material and Methods
2.1 Study area
Magadi taluk of Ramanagara district, Karnataka comprises 7886.9 hectares of forest area with two protected reserved forest areas Savanadurga, and Sidde devara betta state forest, which is fragmented and found throughout the taluk with Arkavathi and Kumudvathi river basins. The forest cover of Magadi taluk comprises Chiluru (36 villages), Kalerikaval (6 villages), Hanumadurga (8 villages), Savanadurga (15 villages), Sidde devara betta (9 villages), Mayanayakana durga (16 villages), Balekatte (12 villages), Gattipura (10 villages), Chakrabhavi (12 villages), Bantarakuppe (21 villages), Kuduru (26 villages), Gadduge (23 villages) and Biskur (23 villages) forest beats [9]. The villages under the jurisdiction of the forest beats were selected for the study (Figure 1).

2.2 Questionnaire survey
A self-administered house hold questionnaire survey [17; 20] was used to collect data on the human-wildlife conflict from the villages of chiluru, kalerikaval, hanumadurga, savanadurga, sidde devara betta, mayanayakana durga, balekatte, gattipura, chakrabhavi, bantarakuppe, kuduru, gadduge and biskur human inhabitant sites. The responses were collected from 200 randomly selected farmers from each site. All questions were close-ended (consisting of multiple options and respondents are required to choose one from among these options and open-ended questions have no options, and respondents are required to answer themselves) for simplicity in quantitative analysis. The questionnaire was prepared in the local language (Kannada) with different perspectives [14], focusing on the following objectives.

- **General information on conflict:** [encounter of the conflict (severe, moderate, less), crop losses, livestock predations (Yes/no)].
- **Crops raiding and livestock predation activity:** [**Crop losses:** list of main crops grown by the farmer, list of problematic animal species, description of surrounding vegetation and habitat type, types of crops damaged by wildlife/domestic animals, stages affected, the timing of the raid, mode of damage, farmer' estimate of crop damage (Minimum maximum) concerning their vulnerability to crop damage by animals.
- **Livestock predation:** Predatory animals, animals predated, timing, and place of predation].
- **Mitigation strategies:** [mitigation measures practiced, percent of adoption, crop and animal-specific measures, indigenous traditional knowledge].

A questionnaire survey was conducted during 2017-2019 with the aid of a local Field Assistant who made the initial contact in each site, field observations including photography were collected to have a visual illustration of the material impacts of conflict on agriculture and livestock, All the responses were pooled and analyzed and expressed as mean responses and per cents. One-way analysis of variance at P ≤ 0.05 significance followed by Duncan multiple range tests was conducted to check the difference in responses obtained

concerning animals and different human inhabitant sites with the help of Xlstat © 2019 Addinsoft. Besides, a general village survey was also conducted to know the impact of conflict in agricultural landscapes of the study area [11, 23].

3. Results and Discussion
Magadi taluk, of Ramanagara District, Karnataka State, belongs to the Eastern dry zone (Zone 5) of agroclimatic zones of Karnataka with deep red clay soil. The climate has four seasons the dry season from January to February, followed by hot weather from March to May, the southwestern monsoon season from June to September, and the northeastern monsoon period from October to December with an average annual rainfall of 883 mm. The people follow settled agriculture with mixed and multi-cropping systems. They mainly depend on southern western and northeastern monsoons whereas, few are dependent on irrigation by borewells and open wells. The major agriculture crops cultivated are rice, millets (sorghum, ragi), pulses (pigeon pea, black gram, green gram, horse gram, field bean, cow pea), oil seeds (castor, sesamum, groundnut, mustard), fiber (cotton), vegetables (carrot, french bean, brinjal, tomato, lady's finger, cucurbits, cluster bean, cowpea, drumstick, curry leaf, gourds), tubers (potato, sweet potato, colacasia, tapioca), fruits (mango, citrus, guava, banana, fig, pomegranate, jack, sapota, gooseberry, custard apple, jamun, papaya, tamarind), spices (chillies, onion, mint, coriander), plantation crops (coconut, areca nut, tamarind, cashew, betle vine) and mulberry. Besides, hose hold cattle such as cow, buffalo, goat, sheep are reared along with poultry birds.

The questionnaire survey (N=200/site) revealed that 47.5 per cent of respondents opinioned severe level of conflict followed by 36.5 per cent at a moderate level and 15.9 percent at less level. The conflict was in the form of crop losses, and livestock predation overall, 68.6 per cent respondents reported crop losses and 29.5 percent reported the livestock predation. The severe level of conflict responses was high in Savanadurga (52.0%), and Sidde devara betta (52.0%), followed by Bhantarakuppe (51.5%) and Chiluru (48.5%) human inhabitant sites and it was followed by Kalerikaval (49.0%), Hanumadurga (47.5%), Mayanayakana durga (46.5%), Balekatte (45.5%), Chakrabhavi (45.0%), Gattipura (44.5%), Kuduru (43.0%), Gadduge (42.0%), and Biskur (41.5%) (Table 1).

The results on responses on vertebrates species involved in conflict and responses on animal conflict concerning to different human inhabitant sites were statistically significant at $p \leq 0.05$ (Table 2 and 3), among the vertebrates wild boar, leopards, monkeys, rodents were found to be highly troublesome species with mean responses of 113.5, 83.5, 70.2 and 61.6 per animal respectively, and it was followed by birds (50.0), mongoose (46.6), fox (45.9), bear (33.2) and hare (31.0) with lesser extent. The responses on animal conflict concerning to different human inhabitant sites the mean responses per site were high in savanadurga (94.8), siddedevarabetta (75.8), chiluru (73.0), bantarakuppe (73.0), human inhabitant sites and they were followed by hanumanadurga (68.4), kalerikaval (52.0), mayanayakanadurga (45.5), balekatte (45.3), biskur (44.1), gadduge (41.9), chakrabhavi (41.5), gattipura (37.7) and kuduru (36.8) (Figure 2 and 3). In recent decades' evolution of vertebrates as a pest in agriculture is highly challenging [23]. The conflict between humans and wildlife in the agricultural landscape is well documented with crop-raiding and livestock

depredation, [8, 11]. Incidence of crop damage is highly influenced by the distance between farmlands and the boundaries of the forests [15, 19]. However, the annual crop losses due to plant pests are estimated to be between 20 to 40 per cent. [4]. The people inhabiting around Savanadurga and Sidde devarabetta mainly depend on farming activities for leading their livelihood. In the present study, the results revealed that the responses on conflict was recorded in all the human inhabitant sites; however, the human inhabitant sites such as Savanadurga, Sidde Devarabetta, Hanumadurga and Chilur recorded the maximum responses on the conflict in terms of crop damage and predation of the livestock.

The responses on crop loss indicated that there was a statistically significant difference in responses at p ≤ 0.05. Wild boar, monkeys, and rodents were predominant troublesome species with a mean response of 113.1, 69.6, and 58.3 per animal, respectively. Besides, birds (49.4), elephants (39.6), sloth bears (33.0), and hares (31.0) are also involved in crop-raiding (Table 4). The responses on elephants were only recorded in Savanadurga, Bantarakuppe, Hanumandurga, Chiluru and Sidde devara betta human inhabitant sites, which were seasonal and predominantly observed during December to May. The crop-raiding activity was nocturnal in most of the cases.In contrast, monkeys, birds, and elephants showed diurnal activity, and it was also noted that wild boar, monkey, birds, and rodents were observed throughout the crop cycle with the peak during the maturity of the crop at the time of harvest and post-harvest. The mode of damage by most of the animals was by trampling the vegetative structures, direct feeding of the crop, and rooting out the sprouted seeds and growing shoots. Whereas, the rodents damaged the tillers by cutting, damaging the inflorescence, fruits, seeds, and hoarded the grains in burrows, while the birds directly damaged the seeds and fruits by perching and feeding. The fresh and dried fodder of *Eupatorium* and *Lantana* bushes provided the immediate and temporary habitat to expand and facilitate the growth of the population. In the survey it was noted that wild boar preferred the nut, tuber crops, sloth bear preferred the sweet potato and Jack fruits, hares preferred the nuts, pulses, and vegetable crops, whereas, the birds, monkeys, elephants, and rodents irrespective of crops they exhibited crop predation. Among the rodents lesser bandicoot, Indian gerbil, soft furred rat, spiny and field mouse were recorded in field crops, three-striped squirrel, black rats and lesser bandicoot in plantation crops and black rat, lesser and greater bandicoots and mouse were recorded in residential areas and were responsible for post-harvest crop losses and poultry and household losses. Among the birds, most of the farmers responded parrots, pigeon, sparrows, and peacock exhibited the crop losses, and it was noticed that the farmers had less knowledge on crop losses created by birds.

The crop losses due to the conflict was observed in all the human inhabitant sites however the response per cent was maximum in Savanadurga (87.0%), Chiluru (78.0%), Sidde devara betta (73.5%) Hanumadurga (72.5%) Bantarkuppe (71.5%) Mayanayakana Durga (69.0%) Kaleri Kaval (68.5%) Chakrabhavi (64.5%) Biskur (64.0%) Kudur (62.5%) Gadduge (61.5%) Gattipura (61.0%) Balekatte (59.5%) (Table 1). By the survey it was observed that the maximum damage was recorded in banana (15.47-52.65%) and groundnut (15.64-48.76%), followed by vegetables (8.21-36.78%), ragi (15.23-36.78%),sweet potato (9.25-27.34%), red gram (7.45-23.32%), paddy (8.6-22.9), fruits (2.76-24.67%), coconut (2.3-16.9%), cowpea (2.3-10.56%), field

bean (1.2-4.58%), green gram(3.2-13.2%), horse gram(0.9-5.37%) and tamarind (1.2-3.3%) (Table 5). The damage and infestation were critical during the maturity and harvesting and post-harvesting stages of the crop. Among the pest's wild boar, rodents, birds, and monkeys showed the dominance and adaptability for depredation of the crops. By the survey, it was also noted that crops like brinjal, radish, chili, horse gram, field bean, castor, and mulberry were less preferred crops by the animals, and a single crop raid can cause notable damage by elephants and wild boars. The damage included not only feeding it included the trampling of the vegetative structures of the crops and made unfit for human use by polluting it with its fecal waste (Table 5).

Herbivores and carnivores have a large home range, due to high energy requirements they need to consume large quantities of food [27, 29]. Hence, foregoing of these large-bodied terrestrial mammal species is likely to be far and is observed, especially in lean times beyond the forest borders to human-inhabited lands to satisfy dietary requirements. Thus, it enabled them to access the nutritious vivid crops and become the important contributors to conflict, and even a single raid accounts for a greater extent of crop losses [18;28]. In the current studies, the crop damage was recorded in banana, groundnut, vegetables, ragi, sweet potato, red gram, paddy, fruits, coconut, cowpea, field bean, green gram, horse gram, and tamarind. Elephant, wild boars, birds, monkeys, sloth bears, and rodents involved in crop losses, but the peak responses were recorded by wild boars, rodents, monkeys, and birds. The crop-raiding activity was nocturnal in most of the cases and occurred predominately during the maturity of the crop, at the time of harvest and post-harvest. The mode of damage was by trampling the vegetative structures, direct feeding of the crop, and rooting out the sprouted seeds, growing shoots, and makes unfit for human use by polluting it with its fecal waste. The results were similar to studies conducted by Sukumar [30], Chakravarthy [5]; Sridhara [28] in elephants and Chauhan *et al.,* [6] in rodents, birds and wild boars.

The issue of the conflict with the farmers was not only through the crop depredation by the herbivores; it also included livestock predation. The difference in responses was statistically significant at p ≤ 0.05, and total occurrence responses per cent on predation were recorded by leopards, wild dog, mongoose, and fox with mean responses of 82.7, 48.9, 46.7, and 45.2 per animal respectively (Table 6). The migration of the herbivores has made the carnivores to move from the range of the forest. In the study region, the movement of farmers to forest regions for grazing their livestock and attraction of predatory animal by domestic dogs due to unethical dumping of poultry wastes are facilitating factors for livestock predation. In the survey, it was noted that the human inhabitant sites Savanadurga, Chilur, Bantarakuppe, Kalerikaval, Sidde Devara Betta, and Hanumandurga faced the high levels of predation with total response per cent of 52.5, 47.5, 43.0, 42.5, 42.0 and 35.5 respectively (Table 1). The predation occurred during the late evening and early morning at grazing fields and sheds and the predated animals were cow, goat, sheep, and poultry birds. The predation of poultry birds was more by the mongoose which was reported at more instances (46.7 mean response). Livestock predation was due to, increase in grazing of livestock, habitat loss, fragmentation of habitat, poaching, prey depletion, has made the carnivores to migrate to human settlements [3, 20]. In the present study, leopards, wild dogs,

fox, and mongoose are involved in predation. The predation occurred during the late evening and early morning at grazing fields and sheds, and the predated animals were a cow, goat, sheep, and poultry birds. The predation of poultry birds by mongoose and leopards being attracted by domestic dogs due to unethical dumping of poultry wastes was the prevalent problem that was recorded during the interview of the farmers.

With interest to mitigating the level of conflict the survey on prevalent management measures practiced by local farmers revealed that majority of farmers followed the erection of old color sarees around the crop (13.6%), the artificial illusion by serial lights, zinc sheets and glass bottles (11.9%), use of scarecrows (11.2%) followed by human guarding at night (8.5%), use of local traps for rats (8.2%) F.M radio as artificial acoustics (7.8%), use of botanicals and phorates as deterrents (6.9%), burning of crackers (6.5%), Use of Local dog (5.9%), artificial fires (3.5%) and sounding through drums (3.5%) (Table 7 and Figure 3). The approach towards the management measure depended on economic status; in some instances, the management measures were species-specific based on their efficacy and feasibility. Though there

was the adoption in the mitigation measures, the efficacy concerning farmer level was not so satisfactory as they lacked the scientific knowledge on behaviour of animals. Although physical barriers such as fences, stone walls, and trenches, relocation progrmmes, trapping, and use of chemicals can protect from crop damage and their widespread use is limited by the costs, maintenance, and efficacy [10, 11]. As a result, alternative mitigation measures have evolved, such as the burning of chilli powder, the use of deterrents, solar and powered lights, and some traditional methods [14, 22]. erection of old color sarees around the crop, use of scarecrows, creation of artificial illusion by serial lights, zinc sheets, and glass bottles, sounding through drums, FM radio as artificial acoustics, burning of crackers, use of a local dog, human guarding at night, artificial fires, for rodents the use of local traps and use of phorate (Thimet) granules as a deterrent were the mitigation measures prevalently practiced and depended on the economic status of the farmer. However, it was noted that there was a lack of scientific knowledge in the application, and the farmers were far from satisfaction on the efficacy of mitigation measures though they adopted it without any effective alternative methods.

Table 1: Impact of human animal conflict on crop loss and livestock predation in and around protected areas of Savanadurga (Magadi).

Human inhabitant sites	Responses on conflict n (%)			Crop losses (n=200) n (%)	Livestock predation (n=200) n (%)
	Severe	Moderate	Less		
Chiluru	97 (48.5%) [e]	74 (37.0%)	29 (14.5%)	156 (78.0%) [b]	95 (47.5%) [b]
Kaleri kaval	98 (49.0%) [d]	77 (38.5%)	25 (12.5%)	137 (68.5%) [g]	85 (42.5%) [d]
Hanumadurga	95 (47.5%) [f]	73 (36.5%)	32 (16.0%)	145 (72.5%) [d]	71 (35.5%) [f]
Savana durga	107 (53.5%) [a]	85 (42.5%)	8 (04.0%)	174 (87.0%) [a]	105 (52.5%) [a]
Sidde devarabetta	104 (52.0%) [b]	83 (41.5%)	13 (06.5%)	147 (73.5%) [c]	84 (42.0%) [e]
Mayanayakana durga	93 (46.5%) [g]	71(35.5%)	36 (18.0%)	138 (69.0%) [f]	53 (26.5%) [h]
Bale katte	91 (45.5%) [h]	69 (34.5%)	40 (20.0%)	119 (59.5%) [m]	54 (27.0%) [g]
Gattipura	89 (44.5%) [j]	66 (33.0%)	45 (22.5%)	122 (61.0%) [l]	25 (12.5%) [k]
Chakrabhavi	90(45.0%) [i]	70 (35.0%)	40 (20.0%)	129 (64.5%) [h]	21 (10.5%) [m]
Bantarakuppe	103 (51.5%) [c]	81 (40.5%)	16 (8.0%)	143 (71.5%) [e]	87 (43.5%) [c]
Kuduru	86 (43.0%) [k]	65 (32.5%)	49 (24.5%)	125 (62.5%) [j]	29 (14.5%) [j]
Gadduge	84 (42.0%) [l]	79 (39.5%)	37 (18.5%)	123 (61.5%) [k]	24 (12.5%) [l]
Biskur	83 (41.5%) [m]	60 (30.0%)	57 (28.5%)	128 (64.0%) [i]	33 (16.5%) [i]
Mean	93.8 (46.9%)	73.1 (36.6%)	31.8 (16.4%)	137.3 (68.6%)	59.0 (29.5%)
(N=200 per site)					

Table 2: Analysis of responses on human animal Conflict in study area.

Sl. No	Animals	Mean responses per animal	Per cent responses	Human inhabitant sites	Mean responses per site	Per cent responses
1	Elephant	42.9[de]* (515)	6.4	Chiluru	73.0[abc]* (804)	10.0
2	Wild boar	113.5[a]* (1471)	18.3	Kaleri kaval	52.0[bcd]* (573)	7.1
3	Rodents	61.6b[cd]* (759)	9.4	Hanumadurga	68.4[abcd]* (753)	9.3
4	Birds	50.0[cde]* (643)	8.0	Savana durga	94.8[a]* (1043)	12.9
5	Hare	31.0[e]* (403)	5.0	Sidde devarabetta	75.8[ab]* (834)	10.3
6	Monkeys	70.2[bc]* (906)	11.2	Mayanayakana durga	45.5[bcd]* (501)	6.3
7	Bear	33.2[e]* (429)	5.3	Bale katte	45.3[bcd]* (499)	6.2
8	Leopards	83.5[b]* (1076)	13.3	Gattipura	37.7[d]* (415)	5.1
9	Mongoose	46.6[cde]* (608)	7.5	Chakrabhavi	41.5[cd]* (457)	5.6
10	Wild dog	50.0[cde]* (636)	7.9	Bantarakuppe	73.0[abc]* (803)	10.0

11	fox	45.9^{cde}* (588)	7.3	Kuduru	36.8^{d}* (405)	5.0
12	-	-	-	Gadduge	41.9^{cd}* (461)	5.7
13	-	-	-	Biskur	44.1^{cd}* (486)	6.0
Observed F value	-	8.54		-	3.64	

(Note: figures in parenthesis indicates total responses obtained with respect to different animal and human inhabitant sites
* Significant at $P \leq 0.05$)

Table 3: Responses on human animal conflict in and around the protected areas of Savanadurga (Magadi)

Human inhabitant sites	Animals											
	Elephant	Wild boar	Rodents	Birds	Hare	Monkeys	Bear	Leopards	Mongoose	Wild dog	Fox	Mean
Chiluru	98	103	116	33	37	54	45	127	66	57	68	73.0
Kaleri kaval	0	117	18	37	35	58	32	114	48	59	55	52.0
Hanumadurga	86	127	104	55	31	76	31	96	39	61	47	68.4
Savana durga	123	167	141	83	42	104	54	136	42	74	77	94.8
Sidde devarabetta	112	94	130	48	26	69	51	123	53	64	64	75.8
Mayanayakana durga	0	115	17	59	25	79	30	63	47	43	23	45.5
Bale katte	0	104	18	62	23	74	32	57	43	51	35	45.3
Gattipura	0	97	20	33	26	54	19	71	41	32	22	37.7
Chakrabhavi	0	105	17	60	27	81	21	23	47	34	42	41.5
Bantarakuppe	96	145	114	34	31	55	42	109	54	60	63	73.0
Kuduru	0	84	23	47	36	68	19	26	36	32	34	36.8
Gadduge	0	105	22	50	34	71	23	57	44	34	21	41.9
Biskur	0	108	19	42	30	63	30	74	48	35	37	44.1
Mean	39.6	113.1	58.3	49.4	31.0	69.6	33.0	82.7	46.7	48.9	45.2	39.6
N=200 per site												

Table 4: Problematic animal species involved in crop losses.

Sl. No	Animal	Mean responses per animal	Crops damaged	Month/ Stage of Occurrence	Source/Habitat	Activity	Mode of Damage	Reported human inhabitant sites
1	Elephant	39.6^{cd}*	Ragi, paddy, banana, tamarind, jack fruit, papaya.	December to May	Migration	Diurnal	Trampling and feeding	Savanadurga, Hanumanadurga, Chiluru, Sidde devra betta, Bantarakuppe
2	Wild boar	113.1^{a}*	Sweet potato, Ragi, ground nut, jowar, Pulses.	Throughout the crop period	Lantana bushes and canopy	Nocturnal	Wallowing	All the human inhabitant sites
3	Rodents	58.3^{bc}*	Ragi, ground nut, pulses.	Pre- and post-harvest	Burrows	Nocturnal	Cutting, Feeding and Hoarding	All the human inhabitant sites
4	Birds	49.4b^{cd}*	Cereals, Fruits	Maturity, harvesting and post-harvest	Tress, bushes and canopy as roosting human inhabitant sites	Diurnal	Eating the berries of the fruit, cereals and oil seeds	All the human inhabitant sites
5	Hare	31.0^{d}*	Vegetables, sweet potato, Pulses.	Maturity, Harvesting	Bushes	Diurnal	Cutting and feeding	All the human inhabitant sites
6	Monkey	69.6^{b}*	Jack fruit, Coconut, Banana, Fruits, Tamarind	Maturity, harvesting and post-harvest	Forests, Translocation programme	Diurnal	Feeding, Cutting, trampling	All the human inhabitant sites
7	Sloth bear	33.0^{cd}*	Jack fruit, sweet potato.	January to July (Fruiting)	Forests	Nocturnal	Feeding	All the human inhabitant sites

(Note: Pooled direct responses by farmers * Significant at $P \leq 0.05$ (observed F value- 11.33))

Table 5: Crop losses due to animal human conflict. (Note: Pooled direct responses by farmers)

Sl. No	Crop	Stages affected	Damage (%) (Min-Max)	Vertebrate pests
1	Ragi	Ear head formation, Harvest and Post - harvest	15.23-36.43	Rodents, Wild boar, peacock, Elephants (occasional)
2	Paddy	Ear head formation, harvest and Post -harvest	08.60-22.90	Rodents, Birds
3	Sweet potato	Fruiting	09.25 - 27.34	Wild boar, Rodents
4	Fruits (Mango, papaya, guava, pomegranate)	Fruiting	02.76 -24.67	Monkeys, Birds, Elephant, Rodents
5	Ground nut	Peg formation, Harvesting	15.64 - 48.76	Rodents, Wild boar, Black-napped Hare
6	Red gram	Pod formation, Harvest	07.54 - 23.32	Rodents, Wild boar,
7	Banana	Fruiting, Tubers	15.47 - 52.65	Monkeys, Wild boar, Elephants (occasional)
8	Vegetables	Fruiting	08.21 - 36.78	Rodents, Wild boar, Black-napped Hare
9	Coconut	Button formation, Nuts	02.30-16.90	Rodents and Monkey
10	Areca nut	Button formation, Nuts	01.3-06.50	Rodents and Monkey
11	Field bean	Pod formation, harvesting	01.2 - 04.58	Rodents
12	Cowpea	Pod formation, harvesting	02.3 - 10.56	Rodents, Wild boar,
13	Green gram	Pod formation, harvesting	03.20-13.20	Rodents, Wild boar,
14	Horse gram	Pod formation, harvesting	0.90 - 05.37	Rodents, Wild boar,
15	Tamarind	Fruits	01.20-03.50	Monkey

Table 6: Livestock predation in the study area.

Sl. No	Predator	Mean responses per animal	Predated animals	Place of predation	Comments	Most reported human inhabitant sites
1	Leopards	82.7[a]*	Cow, buffalo Goat, Sheep, Poultry birds.	Grazing fields, Home sheds.	Secondary attraction by dogs due to poultry wastes	Savanadurga, Hanumandurga, Siddadevabetta, Bantarakuppe, Kaleri kavalu, Chiluru
2	Fox	45.23[b]*	Goat, Sheep, Poultry birds		Predates during the grazing period in the vicinity of forests	
4	Wild dog	48.92[b]*	Cow, buffalo Goat, Sheep, Poultry birds.		Predates during the grazing period in the vicinity of forests	
5	Mongoose	46.7[b]*	Poultry birds	Sheds, Fields	Predation during the foraging at domestic areas.	All the human inhabitant sites
(Note: Pooled direct responses by farmers * Significant at $P \leq 0.05$ (observed F value= 8.23))						

Table 7: Mitigation measures practiced in the study area.

| Sl. No	Management measures practiced	Control measures practiced for crops	Targeted species
1	Fencing	Ragi, jowar, sweet potato	Wild boar, Elephant
2	Burning of Crackers	Ragi, banana, papaya, pulses, groundnut	Wild boar, Birds, Elephant, Sloth bear, Monkey
3	Use of scarecrow.	Ragi, pulses, groundnut, jowar, sweet potato	Birds, Wild boar
3	Artificial illusion of humans by serial lights, zinc sheets and glass bottles	Sweet potato, groundnut	Wild boar
4	Sounding through drums	Ragi, sweet potato, pulses, etc.…	Elephant, wild boar, Birds, Monkey
5	F.M Radio artificial acoustics	Ragi, banana, pulses, groundnut	Wild boar
6	Use of Local dog	Ragi, banana, pulses, groundnut	Wild boar, Monkey
7	Artificial fires	Ragi, banana, pulses, groundnut	Wild boar, Elephant, Sloth bear
8	Human guarding at night	Groundnut, Ragi, banana, pulses	Wild boar, Elephant
9	Erection of old color sarees around the crop	Ragi, banana, pulses, groundnut	Wild boar
10	Use of a different type of rat traps	Ragi, pulses, groundnut, jowar, sweet potato	Rodents
11	Use of phorate and botanicals as a deterrent	Ragi, banana, pulses, groundnut, sweet potato	Wild boar
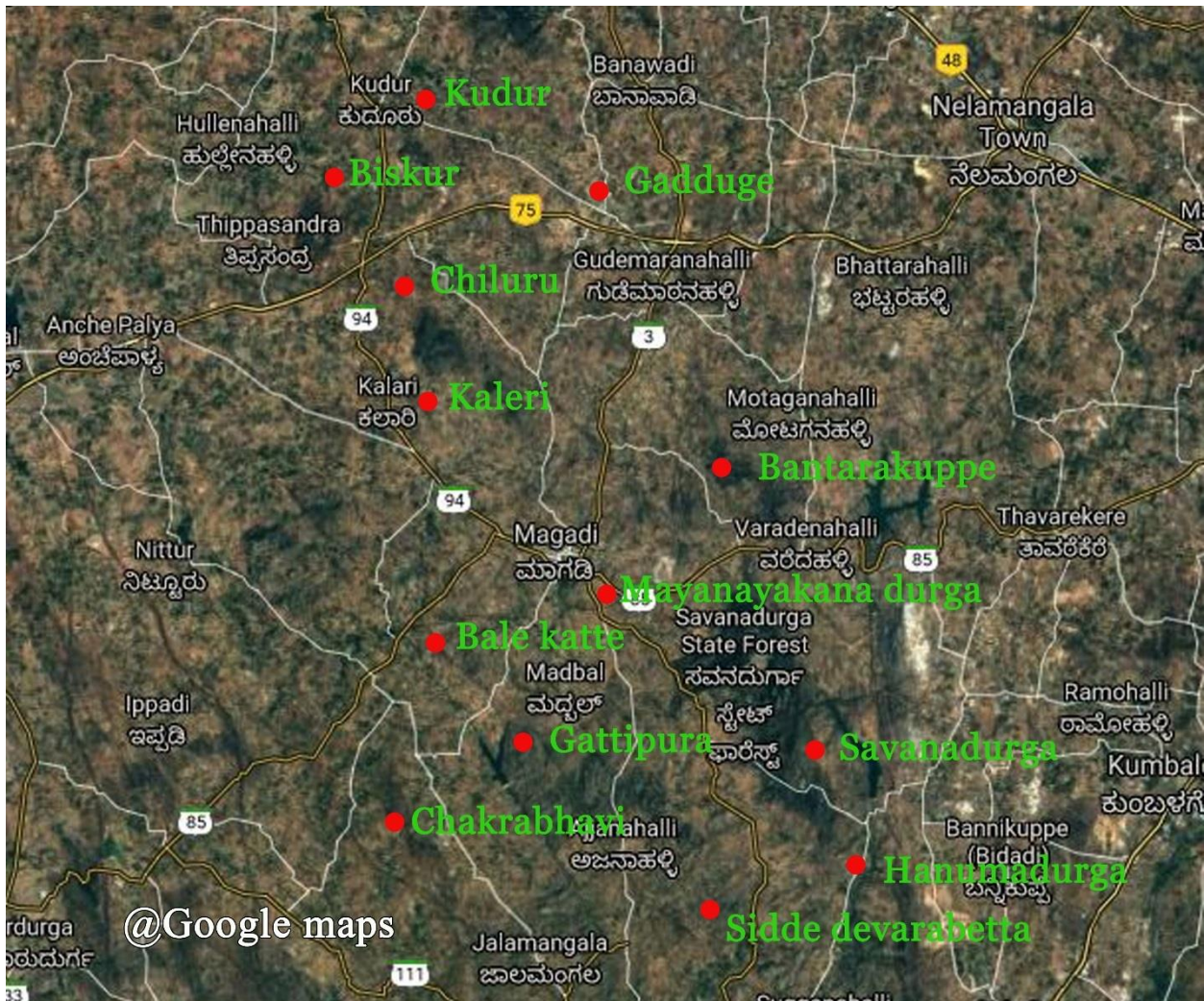
Fig 1: Study area (Savanadurga reserve forest) Magadi taluk, Ramanagara district, Karnataka
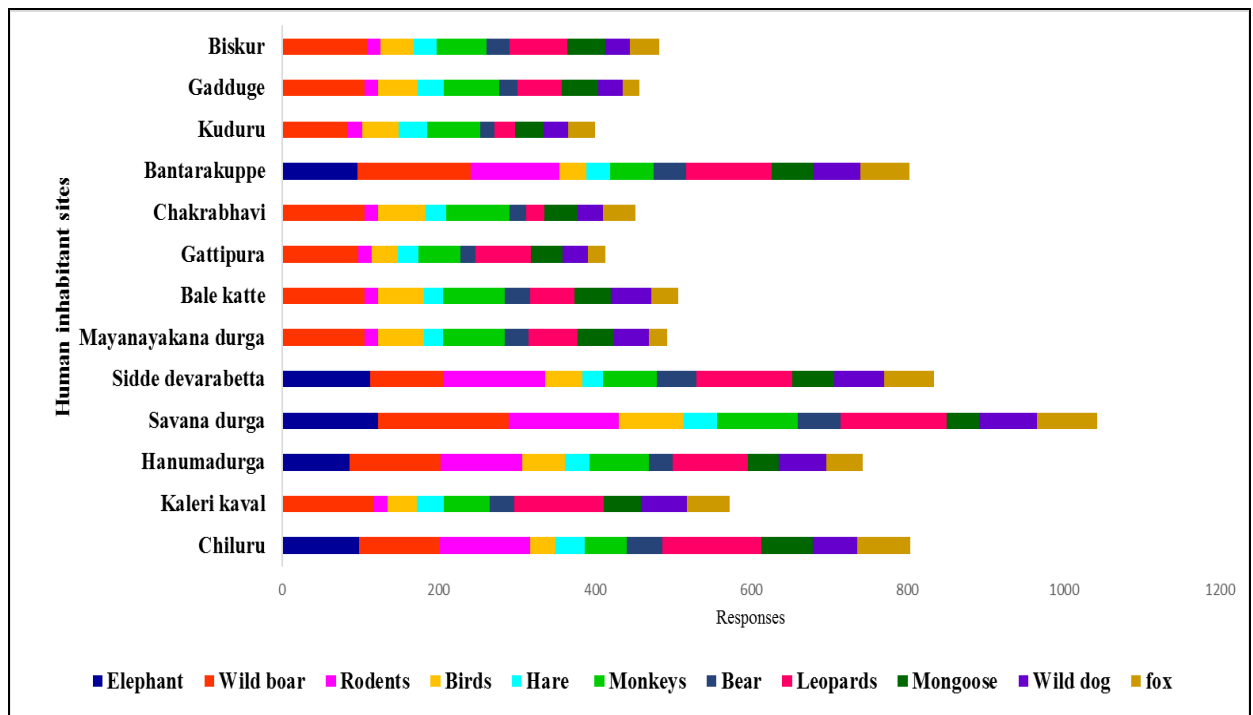

Fig 2: Responses on human animal conflict in and around protected area of Savanadurga (Magadi)
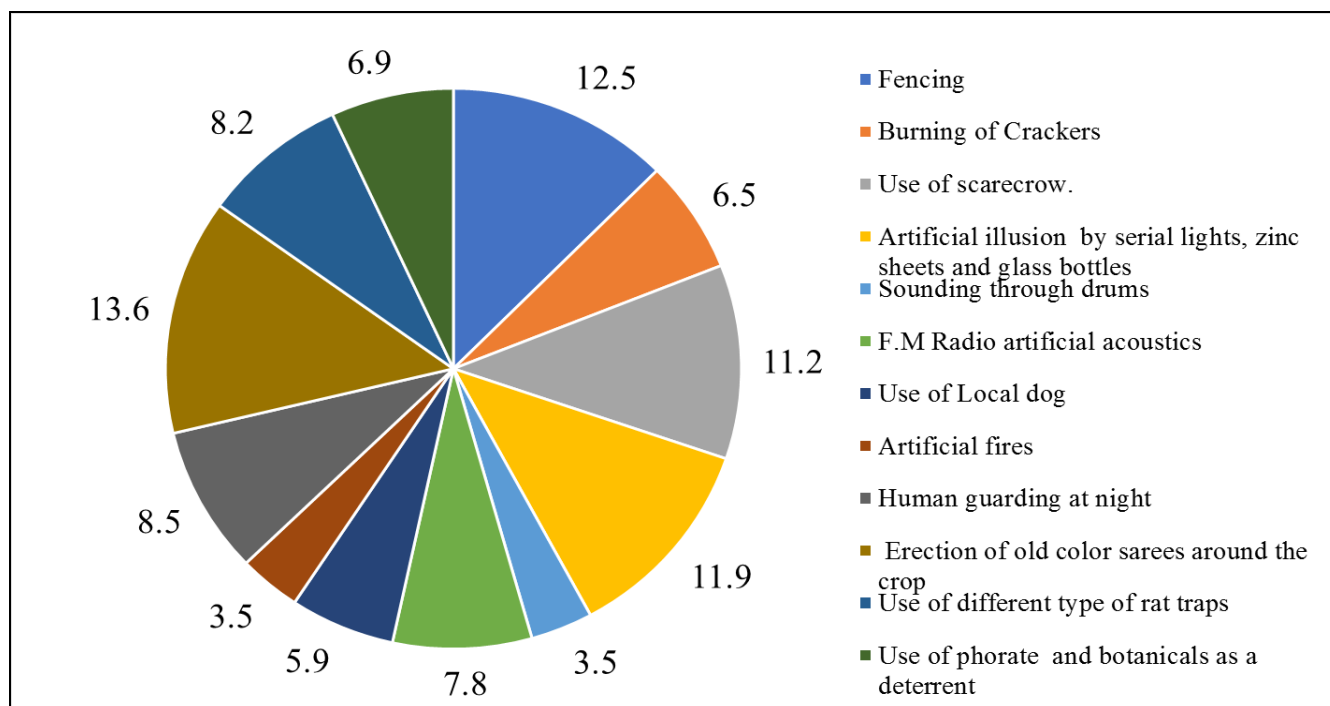
Fig 3: Mitigation measures practiced by farmers in the study area

4. Conclusion

The questionnaire survey on animal and human conflict around the Savanadurga and Sidde devara betta (Magadi) protected area indicated that there was the critical level of conflict in the form of crop losses and livestock predation in the agricultural farms surrounded by forest border, the level of farm losses was peak in Savanadurga, Sidde devra betta, Chilur and Hanumadurga human inhabitant sites. Wild boar, rodents, monkeys, elephants, and birds were responsible for the crop raids and leopard, wild dog, and mongoose were the livestock predators. Though the farmers practiced various crop protection measures to mitigate conflict, the success was far from satisfaction, and scientific knowledge was lacking. However, creating the awareness of conflict, conservation, and demonstration of managemental measures by scientific personnel is in need.

5. Acknowledgements

6. References

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