GOVERNMENT OF KARNATAKA

EVALUATION STUDY ON HUMAN ELEPHANT CONFLICT-THE MITIGATION METHODS EMPLOYED AND ITS IMPACT ON CONFLICT RESOLUTION

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Karnataka Evaluation Authority

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DEPARTMENT OF PLANNING, PROGRAMME MONITORING AND STATISTICS
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Dr. K S Shashidhar, Principal Investigator

Technical Consultancy Services Organization of Karnataka (TECSOK)

KARNATAKA FOREST DEPARTMENT

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Foreword

Karnataka stand first among the states with an estimated population of 6094, amounting to 22 % of the country's elephant population of 29,964. It is estimated that, annually on average about 350 people will be killed due to Human Elephant Conflict (HEC). Further, crops are damaged in an area of about 330 sq.km. With the shrinking and fragmentation of elephant habitats coupled with various developmental activities on the rise, the contact between human and elephants are increasing.

The study entitled 'Evaluation on Human Elephant Conflict the Mitigation Methods Employed and its Impact on Conflict Resolution, was assigned to TECSOK by Karnataka Evaluation Authority (KEA). The study comprises of mapping the details of physical barriers erected from 2014-15 to 2018-19 in the five elephant habitat districts of Ramanagara, Mandya, Mysuru, Chamarajanagar and Kodagu. and classify them into different categories and combinations and evaluate their physical status and effectiveness. Nearly 10% (503 km length) of the barriers constructed has been considered as sample and primary data was collected from 854 farmers located in 128 villages belonging to five districts. Information from KFD, literature survey from other states comprised the secondary source of data for the report.

Results have demonstrated that compact forest with continuous hard boundaries with barricades, have reduced conflict compared to mosaic pattern of forests and agriculture areas where boundaries are also diffused. It is observed that often food crops at maturity are targeted and the fringe villages are often the worst hit. On the basis of number of crop raid cases and the amount of ex gratia paid, the severity of conflict is categorised in to high, moderate and low. This category helps in prioritising areas and plan adequate measures to reduce and manage the conflict. It is observed that Solar fence is an effective barricade and the combination of EPT and Solar fence is the best combined barricades.

Policy recommendations include, providing surveillance drones and other related equipment for better monitoring of elephant herd movement is necessary. Community fencing with solar fencing by farmers can be an area to be explored for better and effective results. Setting up barricades on the interface of forest and villages is one of the important methods to reduce the HEC. Evaluation and monitoring of these methods with a view to find out the best measure both in terms of optimized cost and effectiveness in reducing the conflict is important.

I am sure that the findings of evaluation report and recommendations will provide useful insights for reducing the HEC and increasing effectiveness on conflict resolution. The guidance from the Director (Evaluation) throughout the study and inputs from the ACEO-KEA and experts is greatly appreciated and acknowledged.

The study received support and guidance of the Additional Chief Secretary Planning, Programme Monitoring and Statistics Department, Government of Karnataka. The report was approved in 52nd Technical Committee Meeting. The review of the draft report by KEA, members of the Technical Committee, and an Independent Assessor, has provided useful insights and suggestions to enhance the quality of the report. I duly acknowledge the assistance rendered by all in successful completion of the study.

Chief Evaluation Officer
Karnataka Evaluation Authority

ACKNOWLEDGEMENTS

Karnataka has the population of around 6,100 Elephants and stand first among the States in India. The conflict between human and elephant has been increasing due to shrinking and fragmentation of habitat due to various developmental activities. Karnataka has been adopting several measures both short and long term to reduce the conflict. Inspite of these efforts the human elephant conflict is increasing and is a matter of concern to the Government.

In view of this, Karnataka Evaluation Authority has entrusted TECSOK to carryout an Evaluation Study on Human Elephant Conflict - The Mitigation Methods employed and its impact on conflict resolution. The Study has been carried out in five districts viz., Ramanagara, Mandya, Mysuru, Chamarajnagara and Kodagu which are the major elephant habitats and have in large population of elephants. The prime objective of the Study was to evaluate the impact of four types of barricades in reducing the conflict. The study period of 2014-15 to 2018-19 has been considered for the evaluation.

As part of Study, extensive field investigation was carried out in five districts in order to have the first hand information on different types of barricades, its present status and the impact of these barricades in mitigating the conflict. During the course of study, detailed interactions were held with persons who are affected from elephant raids, members of the society / village, different level of officers in Karnataka Forest Department through structured questionnaires. Focus Group Discussions were also held with villagers and knowledgeable members to solicit their views on possible measures for reducing the conflict.

Based on the primary and secondary sources and also inputs gathered during the field investigation, the Evaluation Report has been prepared and submitted to KEA. The Report, in addition to detailed discussion on findings during the study, also comprises long term and short term recommendations for consideration of KEA and Karnataka Forest Department for implementation, wherever possible and feasible.

TECSOK is grateful to KEA for entrusting this Evaluation Study. We acknowledge the guidance and support extended by Sri. Hari Kumar Jha, IFS, Chief Evaluation Officer, KEA, Dr.A V Manjunatha, Director (Evaluation) and the entire team in KEA for completion of the Study successfully.

TECSOK places on record the support and cooperation extended by the Principal Chief Conservator of Forest (HOFF) and Principal Chief Conservator of Forest (WL & CWW) during the study. We are also thankful for the field level officers of Forest Department in study districts for their timely and valuable support, without which study would not have been completed in time. TECSOK also appreciate the support and involvement of local beneficiaries, opinion leaders, policy makers and other stakeholders for their valuable input and support during the field investigation.

The hard work and sincere efforts put in by the Study Team lead by Dr. K S Shashidhar,IFS (Retd.,) deserve appreciation and I compliment them.

We do hope, this Evaluation Study Report will be useful to KEA, Karnataka Forest Department and others stakeholders for initiating further measures required to mitigate the human elephant conflict in the coming years.

(Ramananda Nayak)
Chief Executive Officer and
Chief Adviser
TECSOK

CONTENTS

List of Abbreviations

ADS	–	Anti depredation squad
APCCF	–	Additional Principal Chief Conservator of Forests
BRT	-	Biligirirangana Tiger Reserve
EPT	–	Elephant Proof Trench
ER	–	Elephant Reserve
FD	–	Forest Department
FGD	–	Focus Group Discussion
HEC	–	Human Elephant Conflict
IUCN	–	International Union for Conservation of Natural Resources
KEA	–	Karnataka Evaluation Authority
KFD	–	Karnataka Forest Department
MM Hills	-	Male Mahadeshwara Hills
NP	–	National Park
PA	–	Protected Area
PCCF	–	Principal Chief Conservator of Forests
RFO	–	Range Forest Officer
TECSOK	–	Technical Consultancy Services Organization of Karnataka
ToR	–	Terms of Reference
WL	–	Wildlife

1. Executive Summary

ES:1 The Evaluation study on Human Elephant conflict, the mitigation methods employed and its impact on conflict resolution was assigned to TECSOK by Karnataka Evaluation Authority. The period of study was pertaining to the measures taken during 2014-15 to 2018-19 in the five elephant habitat districts of Ramanagara, Mandya, Mysuru, Chamarajanagar and Kodagu. The purpose of the study is mainly to evaluate the various measures taken to reduce the human elephant conflict (HEC) and to arrive at the most efficient measure with cost effective. With the HEC assuming alarming proportions in the recent past and considerable amount is incurred in erecting physical barriers in the form of barricades to manage the conflict and also payment of ex gratia for crop, property damages and injuries and death of humans. On the other side death of elephants is also a matter of concern. The genesis of the conflict is mainly due to changes in the landscape resulting in fragmentation and shrinking of elephant habitats and at the same time increase in the elephant population.

ES:2 The purpose of the study comprises of mapping the details of physical barriers erected during the study period and classify them into different categories and combinations and evaluate their physical status and effectiveness. With increase in HEC resulting in increased expenditure on erecting the barricades, the cost benefit analysis of these barricades also needs to be looked into. The primary indicators of the severity of conflict are the damages occurring to crops and properties of farmers, injuries and deaths of humans due to conflicts. The pattern of these raids, seasonality, frequency, stages of the crop raids, assessment of extent of damages, payment of ex gratia and gaps in the process are studied and presented. With the level of vulnerability and risk due to conflicts is varying in these areas, mapping them according to different levels will help in taking precautionary and forewarning measures to reduce the conflict. These various measures adopted should ultimately result in reducing the HEC and bring it under managing levels. Evaluation methodology comprised of collecting primary data on sampling basis (10 %) of the barricades constructed during the study period on its

physical status and classifying them into different categories. With a total of 5037 km of barricades constructed during the period across all types of barricades, about 503 km length of sample size was taken up. The sample barricades were selected through stratified random sampling in sample villages. Sample villages were selected (10%) from the listed population (villages) with each village having at least one crop raid. About 128 villages were selected for sampling to collect data on location of villages with respect to forest boundaries, crop raids, seasonality, time, extent of damage, amount of ex gratia paid, adequacy of amount and gaps in the process of payment. Data from 854 affected farmers were collected across the study area. Collecting data from KFD, literature survey from other states comprised the secondary source of data for the report.

ES: 3 The landscape of the study area has been categorised into three, with areas of Ramanagara, Mandya, Mysuru and Hunusur having flat terrain and fragmented forests and diffused forest boundaries, interspersed with agriculture and habitation. The second category being, flat and plain terrain with continuous forests and hard boundaries as seen in Chamarajanagar, Bandipur and Nagarahole. The third category of areas in Kodagu is hilly and undulating terrain with forests and plantation crops like coffee, pepper and cardamom. This classification will help in analysing problems of HEC which are common and also arriving at uniform recommendations as to the measures to reduce and manage the conflict.

ES:4 Data on status of barricades shows that most of the EPT in Ramanagara district, Mysuru, Chamarajanagar and Madikeri (T) was categorized as poor (more than 50 % damaged) to moderate and many of them are not maintained. In Bandipur and Nagarahole, EPT's are in functional status with most of it falling under good and moderate category. Some of the EPT's which are constructed during 2014-15 are not maintained due to non-receipt or no provision of funds, are invariably abandoned after few years due to accumulation of silt, rubbles and weeds growing rendering the whole exercise futile. Solar fence constructed in the study area has been functional except in few cases, where it is constructed in earlier years (2014-15) and not maintained as observed in Ramanagara. In Mysuru, Chamarajanagar, Bandipur, Nagarahole and

Virajpete they are well maintained and functional. Considering that EPT or solar fencing cannot be standalone in reducing the conflict, combination of solar and EPT have given good results and are found to be more effective compared to either of the two independently. In Mysuru, Bandipur and Nagarahole combination of solar and EPT have given good results. Combination of solar tentacle with Rail fence in Nagarahole has good deterrence abilities. The overall working of these EPTs in the study area is not satisfactory as most of them lack maintenance. Solar fence both ground and tentacle appear to be effective and optimises cost wherever they are maintained. Rail fence as a barricade is effective and has considerably reduced the conflict in site specific areas. But cost and its limitation of usage in specific sites and some technical issues needs to be addressed. It is inferred that compact forest with continuous hard boundaries with barricades, have reduced conflict compared to mosaic pattern of forests and agriculture areas where boundaries are also diffused.

ES:5 Data on correlation of barricades and number of crop raid cases though do not indicate any clear trend, declining crop raid cases are seen in Nagarahole with its 265 km length of barricades. Cases being high in Ramanagara, Mysuru and Virajpete with barricades ranging from 9 to 40 km length indicates less barricades constructed during the study period, In such cases barricading fragmented patches could be an unviable option. In such scenario farmers have resorted to solar fence barricades for their farms with fairly successful outcome. All these barriers need regular maintenance and monitoring which has to be systematically taken up rather than adhoc approach and also before erecting new barricades.

ES:6 Data on crop raids and ex gratia payment was collected in about 128 villages and 854 farmers were interviewed. Villages located in proximity to forest boundaries of less than one km and on the fringes have high percentage of crop raids as seen in Chamarajanagar, Hunusur, Madikeri and Nagarahole. As the distance increases beyond 1 km there is a decreasing trend in the percentage of raids and exception to this observation is Ramanagara, Mysuru, Mandya where proximity of villages does not matter, as far as percentage of raids are concerned as forests are interspersed with agriculture in these areas. In case of Madikeri and Virajpete the villages which are

located beyond 1 km from forest boundary also had high percentage of crop raids (62-68%) probably due to the physiography of the area and the villages might have been spread out. Most of the crop raids takes place during night times and forewarning and adequate precautions need to be taken to prevent the raid and drive the elephants. Damages due to crop raid occur not only due to feeding on the crops but also due to movement and trampling in the area and often rendering it unfit for use. Generally small and marginal farmers whose holdings are less than one acre (about 55 % damaged) who grow field crops like Ragi, maize, Paddy, Jowar and pulses are the worst hit. Most of the crop raids takes place during the months between September to March. This period coincides with the post monsoon when most of the field crops attain maturity. This is the period when adequate early warning and precautions need to be taken to prevent the damage to crop and property. It is observed that though there is no preference for type of crop, often food crops at maturity are targeted and the fringe villages are often the worst hit.

ES:7 Ex gratia payment involves the total amount to be paid for the damages and the time of disbursement. The crop damage cases and ex gratia is mainly seen as an effect of the HEC. The conflict has already damaged and whatever compensation is being made is mainly supportive in nature, the economic loss and the emotional factor cannot be fully compensated. The affected farmers have generally expressed that the ex-gratia amount is inadequate and not commensurate with the actual loss. Many farmers are of the opinion that there has been delay in receipt of the ex-gratia ranging from 3 months to a year. However, these short comings have been taken care by the Department and Government with the introduction of e- Parihar and also setting aside funds exclusively for payment of ex gratia outside the purview of plan allocation. On the basis of number of crop raid cases and the amount of ex gratia paid, the severity of conflict is categorised in to high, moderate and low. Villages around Ramanagara, Virajpete, Madikeri(T) and Bandipur have been categorised as High-risk areas. Mysuru, Chamarajanagar, Nagarahole and Madikeri (WL) are categorised as moderate risk areas. Villages around Hunusur and Mandya are put under low-risk areas. This category helps in prioritising areas and plan adequate measures to reduce and manage the conflict.

ES:8 Community involvement needs to be ensured at every stage beginning from selection of site for barricades. Several complementary measures such as guarding or night watch, fire, drum beating, crackers are used to drive the elephants. However, it is important that forewarning and communication plays a role in reducing the damages before it occurs. FD should take the initiative of forming a network with selected people (youth) from the villages and form a network of communication for early warning of elephant and possible raids. This communication network and putting it in place will go a long way in preventing the conflict and reducing the losses eventually.

ES:9 Farmers expressed that Solar fence is an effective barricade and the combination of EPT and Solar fence is the best combined barricades. They also opined that maintenance of these barricades is important for its effectiveness. Many of the farmers have agreed that there is a need to discourage growing crops like banana which attract elephants. But they are not interested in changing their cropping patterns and in many cases provision for buffer cropping is not a viable option.

ES:10 Many of the field personnel of the department expressed that there is a need to set up a full fledged Anti Depredation Squad (ADS) or revive it in all areas where HEC is there. They should be provided with vehicles; man powers and has to be exclusively engaged in preventing and managing the HEC. Providing surveillance drones and other related equipment for better monitoring of elephant herd movement is necessary.

ES:11 From the data available on projection of physical and financial outlay there is an increased projection both in terms of physical targets and the financial expenditure. It is observed that Madikeri territorial and Wildlife divisions both have increased projection of financial requirements in the coming years, indicating need for more barricades and probable increased level of conflict. Madikeri Division has projected considerable increase in their projection from Rs.32.9 lakhs to Rs.3399 lakhs and so also the physical targets projected. Bandipur and Nagarahole also have projected increased financial outlay and the physical targets projected in the coming years. These outlays indicate that barricades are being taken up in a phased manner to cover the boundaries.

Chapter –2 : Introduction & Study Design

2.1 Introduction

India is one of the main habitats of Asian elephants in the world with an estimated population of 29,964. Karnataka stand first among the states with an estimated population of 6094. With the shrinking and fragmentation of elephant habitats coupled with various developmental activities on the rise, the contact between human and elephants are increasing. The Human Elephant conflicts is due to complex interactions between human and elephants resulting in damaging consequences on both sides. Most of the elephant habitat states have been adopting several measures to reduce this conflict over a period of time. Despite this, the intensity and degree of conflict has been on the rise. Karnataka has been adopting several measures both short and long term to reduce the conflict. Among the short-term measures, setting up barricades on the interface of forest and villages is one of the important methods to reduce the HEC. Evaluation and monitoring of these methods with a view to find out the best measure both in terms of optimized cost and effectiveness in reducing the conflict is important.

The present evaluation study covers the barricades in the major five elephant habitat districts of the state and its status and examine the best single or combination of barricade which can reduce the conflict.

As per the terms and conditions of the study, TECSOK is required to prepare and submit a Final Report after completing the work. This Report contains a presentation of findings and analysis of the results based on the work completed.

2.2 Background

The Asian elephant *Elephas maximus* is the largest terrestrial mammal in India's forests requiring large tracts for its forage and water. Its interaction with humans has always existed in nature and will continue to be there both recognized as per the law of the land and also nature desires it to be. The first estimate of wild elephant population was taken up in 2005 and estimated to be 21, 200 in the country. India is the only country having largest Asian population to an extent of 29, 964 as per the recent estimates in 2019.

Project Elephant was launched in 1992 in 13 states in the country including the state of Karnataka. The main objectives of this project were to protect the elephants and their habitat and corridors and to address the increasing Human - Elephant Conflict (HEC). About 32 Elephant Reserves (ER) are declared in the country under the project with a total area of 65, 507.42 Sq. km. In Karnataka, range of *Brahmagiri – Nilligiris – Eastern Ghats* is declared as the Elephant Reserve. About 101 areas are identified as Elephant Corridors in the country. There are about eight main populations in Southern India and each are fragmented from others. Many of the corridors are under threat due to change in landscape resulting in HEC. However, the silver line being restoring some of these corridorsI in Karnataka as well as in the country. One such is the *Kaniyanpura- Moyar* corridor is secured and *Chamarajanagar – Talamalai – Mudahalli* is in process of restoring in Karnataka.

Karnataka stands first in the country with a population of 6094 (as per estimates of 2019) amounting to about 22 % of the country's elephant population. The total forest area in the state of Karnataka is 38,575 Sq.km and with an elephant population of 6094, the average forest area per elephant is around 6.3 Sq. km.

Elephants are migratory in nature. One hypothesis mentions that elephants migrate at the onset of rains to far away areas from permanent water sources. This would avoid competition with other populations and will get access to new growth forage higher in primary productivity than what they would have got if they had stayed back in their original areas. Various studies documenting Asian elephants' behavior in deciduous forests of southern India, with numerous water sources, reported elephants migrate to anywhere between 20 and 50 km. Generally, these movements occur during the changing seasons. One possible explanation is during the dry season, elephants are restricted to habitats close to permanent water sources. With the onset of rains, elephants do not confine to these permanent water sources and move away from their dry season ranges towards areas that are greener, more productive, and less in competition. It is also observed that not all elephants migrate, only some of them are in the habit of migration. While doing so (migration) it allows sufficient time for re growth of exhausted grazing areas.

In India, elephant's territory comprises of variety of habitats and landscapes. Ranging

from large contiguous forest areas surrounded by crop fields, to highly degraded areas interspersed with agricultural field and encroachments. In addition, they are also found in fragmented landscapes with a mosaic of crop fields, plantations and patches of forest. Another interesting landscape is the forest interspersed with coffee plantation as seen in Kodagu.

The major issues facing the elephants are habitat loss mainly through land use changes, habitat fragmentation and persecution as crop raiders and property damages. All these have resulted in increased Human-Elephant interface and eventually resulting in conflicts.

Human–Elephant Conflict arises because of direct or indirect interactions in the above-mentioned scenario mostly in degraded and fragmented habitats resulting in man's inability to appreciate the concept of co-existence in nature with specific to elephants. The underlying reasons for conflict are mainly the economic losses to agriculture, loss of property, destruction of crops mainly commercial, often injury and death to human beings and all in search of resources such as food and water.

Different types of strategies have been evolved and adopted to manage and mitigate the Human-Elephant Conflict in the country as well as in the state also. Despite these, human-elephant conflict remains persistent mainly due to the fact that most of these strategies are aimed at tackling site specific issues and as short-term measures rather than looking into the reasons for the conflict.

Genesis of Conflict: As human population pushes itself to change the landscape and encroach into elephant habitat and territory on one hand and the increase in population of elephants on the other hand invariably brings both in close proximity resulting in conflicts.

Studies on conflict between elephants and humans in Asia and in Africa have identified crop raiding as the main form of conflict. Some of the studies show that elephants habituating in contiguous and compact areas, not all of the elephants in a population raid crops. But, if the area has fragmented landscapes, the entire population may be involved in elephant-human conflict.

Increase in the competition between humans and elephants for land and its resources eventually resulted in expansion of agriculture areas, which were earlier either habitats or

corridors for elephants and its movements. This has probably resulted in elephants getting over crowded in small areas or pockets and thus increasing the Human - Elephant conflicts through crop raiding in surrounding areas. Changes in the landscape are one of the main reasons for genesis of conflict where in traditional migratory routes of elephants have been converted into cropped areas and human habitation making the animal behavior aggressive. In addition, increase in elephant population especially in the Protected Areas (PA) with conservation measures and the loss and fragmented habitats has raised a question whether the carrying capacity of the elephant habitats have been exceeded. Although elephants are mostly confined to PA's still there is sizeable population outside these PA's where human density is ever increasing resulting in increased conflicts.

Few examples suggest that how conflict arises due to human intervention for his benefits ignoring the other aspects has resulted in elephants expanding their territory to adjoining areas where they were not there earlier. Classic case of Upper Assam bordering Mon District of Nagaland, here the vast tracts of wooded areas have been converted into Tea estates and as a result they started visiting adjoining areas of Nagaland in districts of Mon and Wokha.

In another case, in Arunachal where the elephants use to migrate to the hills during summer and return to foot hills by winter and with the passage of time, the elephants remained there well into autumn and also somewhat in winter as there is not much for them in terms of food and water to return to the foot hills.

Mitigation Management & Crop Compensation: The figures for the years between 2014-15 and 2017-18 show that in the country, there has been human deaths of 1557 people due to elephants and an amount of Rs. 180 crores have been paid as compensation for crop damages and human lives highlighting the magnitude of the problem. In all probabilities the pattern for future would be on the increasing unless a well-planned strategy is adopted and implemented.

Management of Human elephant conflict has been in effect earlier through some traditional methods which are in practice even now. Measures like driving the elephants with noise and fire, guarding the crops with towers and *Machan* and alerting the

community are some of them. These are in practice mainly due to economic reasons. What started as simple barriers have led to modern type of barriers which is being adopted now for effective management of the conflict. In some area's farmers were using buffer crop with unpalatable crops such as mulberry as seen in Channapatna taluk and also crops like sun flower and lime are not preferred by the elephants. Buffer crop with chilies has been an effective measure. But all these traditional measures including the repellent measures have been effective only for a short term and in a limited way. Buffer cropping will be a limitation with marginal and small farmers.

This limited effectiveness of some of these traditional measures further led to exploring other more effective methods to manage the conflict. In this regard physical barriers are more seen as medium to long term solutions in areas of severe conflicts. Barriers such as Elephant Proof Trenches (EPT), Solar Fence (Ground and Tentacle types), Rubble stone wall and Railway line barricades are being taken up. These are being erected either singly or in combination, depending on the terrain and magnitude of problem. Though these are effective, they are expensive and require regular maintenance and often results may not be on the expected lines. Especially measures such as Elephant Proof Trenches and Solar fencing needs regular maintenance to be an effective barrier.

Karnataka, besides having largest elephant population in the Country, has also strengthened the first elephant corridor in the Country. More than two decades ago, the Kaniyanpura elephant corridor located to the north of the Moyar River gorge in Bandipur National Park was under distinct threat of being severed, with consequences for the movement of dozens or even a few hundred elephants between the western sector of Bandipur and its eastern sector which eventually connects to the forests of Sathyamangalam in Tamil Nadu and Chamarajanagar in Karnataka.

It was estimated that 90% of Karnataka's elephant population habitat is within areas comprising of mostly National Parks, Wildlife Sanctuaries and Reserve Forests. Another 8% or so inhabited in co-existence zones, and only about 2% moved outside these areas, where they came into acute conflict with human beings.

The five districts covered under the study comprises of sizeable forest area. Ramanagara District with 414.54 sq. km, Mandya with 4961 Sq. km, Mysore with 430 Sq.km,

Chamarajanagar with 2313 Sq.km and Kodagu with 3481 Sq. km. Total forest area for these five districts is around 15, 469 Sq. km, which is about 40% of the total forest area.

Considering the Human Elephant Conflicts have been steadily on the rise, Karnataka Forest Department (Wild Life Wing) has taken various relief measures to mitigate this issue. During the year 2014-15 to 2018-19 (study period) a total of 781 km. of EPT, 1424 km. of Solar fencing, 2749 Cu.m. of Rubble stone wall and 84 km of Rail fence were constructed to manage the conflict.

As per the data available from the KFD, during the study period of five years, a total barricades length of 935.16 km across all type of barricades have been constructed. Further, a total amount of Rs.12525.7 lakhs have been spent on these barricades.

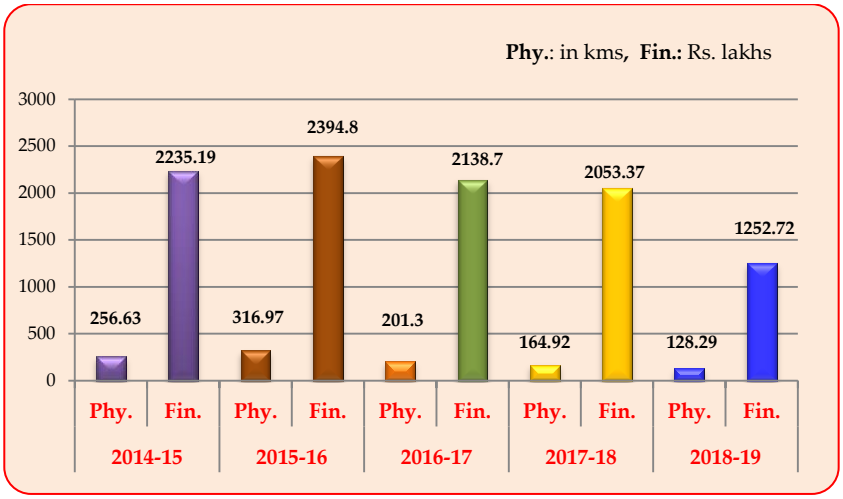
The details are as under :

Physical and Financial achievements during the study period

Physical achievements in kilometres
Financial achievements in Rs. Lakhs

District / Division	Year											
	2014-15		2015-16		2016-17		2017-18		2018-19		Total	
	Phy.	Fin.	Phy.	Fin.	Phy.	Fin.	Phy.	Fin.	Phy.	Fin.	Phy.	Fin.
Ramanagara	6.86	12.74	-	-	3.0	6.63	-	-	-	-	9.86	19.36
Mysuru	1.25	2.12	-	-	0.29	19.89	9	20.9	30.8	125.42	31.34	168.34
Hunusuru	9.87	38.46	6.53	16.71	-	-	0.02	3.20	-	-	16.47	58.37
Chamaraj-Nagar	131.62	292.5	264.29	613.35	60.48	290.58	75.57	425.17	44.28	299.27	576.24	1929.87
Mandya*	-	-	-	-	-	-	-	-	-	-	-	-
Kodagu Madikeri -T	15.45	76.17	18.91	105.67	40.33	270.11	31.4	187.6	4.36	16.99	110.45	656.54
Madikeri WL*	14.30	56.07	5.00	37.88	Nil	Nil	Nil	Nil	6.15	5.82	25.45	99.77
Virajpete	1.12 + 107 posts	15.83	318 posts	31.49	8.02	46.59	-	-	-	-	9.22	93.91
Bandipur	71.0	547.4	3.8	134.8	75.71	892.0	25.5	324.3	1.7	14.59	177.7	1913.1
Nagarahole*	3.16	1193.90	10.44	1452.90	13.47	612.90	23.43	1110.4	41.0	790.2	91.5	5160.3
Total	**256.63**	**2235.19**	**316.97**	**2394.80**	**201.3**	**2138.7**	**164.92**	**2053.37**	**128.29**	**1252.72**	**1068.11**	**12525.7**

Physical and Financial Achievements over five years are graphically represented below:



It can be seen from the above table that during the study period there has been increase in both the extent of construction of barricades and also the amount spent on the same. However, in case of Ramanagara, with the bifurcation of the wildlife wing, most of the works are taken up by Wildlife wing which is the reason of not having any physical progress during 2017-18 and 2018-19. In case of Mysuru, from mere 1.25 km in 2014-15 it rises to 30.8 km in 2018-19. The amount spent on construction of barricades went up from Rs.2.12 Lakhs to Rs.125.42 lakhs. In case of Chamarajanagar, the construction of barricades has been steady during the years with a total coverage of 576.24 km in five years. In Madikeri (T) division, a total of 110.45 km length has been constructed incurring an expenditure of Rs.656.54 lakhs. Bandipur has constructed about 177.7 km of length with an expenditure of Rs.1913.1 lakhs. The total amount spent is also increased over the five years to 1929.87 lakhs of rupees. Nagarahole with a total length of 91.5 km. has spent an amount of Rs.5160 lakhs during the study period. The trend indicates that, there is a need for construction of barricades in a planned manner and both the construction of barricades as well as amount spent on construction is on the rise. It is expected that, the barricades are to be covered all along the length of the boundary in these forests area.

Barricade-wise construction during the Study period in different districts (in KM)

District / Division	2014-15				2015-16				2016-17				2017-18				2018-19			
	EPT	Solar	Combo	Rail	EPT	Solar	Combo	Rail	EPT	Solar	Combo	Rail	EPT	Solar	Combo	Rail	EPT	Solar	Combo	Rail
Ramanagara	1.8	2.0	-	-	-	-	-	-	-	1.0	-	-	-	-	-	-	-	-	-	-
Mysuru	-	-												9.0	-	-	3.0	-	19.0	-
Hunusur										0.09 spl										
Chamarajnagar	37.9	19.5	14.0	-	7.0	14.0	7.0	-	10.7	12.0	14.5	-	14.4	-	3.0	-	7.3	-	-	-
Madikeri (T)	3.0	-	-	-	2.0	-	-	-	10.8	-	-	-	0.8	-	-	-	0.8	-	-	-
Madikeri (WL)	-	-	-	-	-	-	-	-	20.0	3.0	4.5	-	-	-	-	-	-	-	-	-
Virajpete	-	-	-	-	-	-	-	-	-	-	-	-	5.0	3.3	-	-	-	-	-	-
Bandipur	4.2	-	6.3	-	13.4	-	-	0.4	3.5	-	-	0.37	7.1	-	-	0.21	1.68	5.2	13.0	5.0
Nagarahole	6.2	-	6.02	-	-	-	-	-	2.45	0.8	2.8	6.12	3.0	-	-	-	16.02	4.0	17.0	11.15

It is observed that during the period, in Ramanagara, the barricades were predominantly solar fence and to a much less degree EPT out of the total barricades taken up, indicating preference for solar fence which appears to have better deterrence abilities in that landscape. However, there is not much progress in subsequent years about the increase in the physical achievement due to the bifurcation. Mysuru has steadily increased its quantum of barricades constructed during the study period with more emphasis on Solar and combination with EPT. Hunusur has some EPT and solar constructed during 2014-15 and 2015-16 and not much afterwards. Chamarajanagar has steadily constructed barricades during the entire study period with peak achievements in 2014-15 and 2015-16. The barricades are mostly EPT, Solar and in combination. This indicates the need for barricades and also those which have been erected are reasonably functioning well. The district of Mandya did not have any barricades constructed during the study period. Madikeri Territorial division has more EPT's and solar fence constructed between 2014-15 to 2017-18. However, it has been relatively less in Madikeri Wildlife division and mostly it is EPT, and combination of solar and EPT. In Virajpete it is mostly EPT taken up during 2014-15 and 2016-17. In Bandipur, between 2014-15 and 2017-18 good number of barricades were constructed (about 175 km) and mostly it has been EPT, followed by solar and rail fence. Indicating that EPT has been functioning well and with the rail fence being another barricade, the conflict has been somewhat reduced. In Nagarahole, over the period the construction of barricades showed steady increase with emphasis on EPT followed by solar and rail fence.

Overall, most of the barricades constructed during the study period is EPT and Solar and some in combination in almost all the districts. With addition of rail fence in Bandipur and Nagarahole in subsequent years. It appears that solar and combination of solar and EPT appears to have better functional ability.

In spite of all the measures human elephant conflicts continue and it is a challenging task for the Forest Department. An effective solution has to be determined to minimize and manage the conflict and various issues related to HEC.

2.3 Purpose of the Study

The purpose of the study is to collect and map details of the physical barriers erected/constructed in the five districts of Ramanagara, Mandya, Mysuru, Chamarajanagar and Kodagu. The period of evaluation is from 2014-15 to 2018-19 and classifying them into different categories and combinations.

The evaluation study also assists in deciding the extent of barricades covered already vis a vis of the forest boundaries and adopt measures to mitigate the conflict by covering the sensitive areas. Depending on the site, whether a single barricade or combination of barricades will be effective in reducing the conflict can be arrived at. At the same time the status of barriers and the maintenance or lack of maintenance and the reasons for the same will be brought out. It is important to bring out the sensitive areas of conflict by categorizing them into high, moderate and low risk areas in a range. This will enable the planners to prioritize the areas for taking up measures to mitigate the conflict by combination of barricades, complimentary measures and also look into long term measures.

Among the various measures, physical barriers are one of the short-term measures adopted in HEC. Along with this, various complementary measures are also adopted to reduce the conflict. In Karnataka various other measures have been adopted to reduce the conflict, its effectiveness and adopting some of them in a systematic manner with the help of the FD and the community are being looked into.

An effort has been made to look into the cost and benefit analysis of barricade by solar fence and look into the optimal cost to reduce the conflict.

2.4 Context and Objectives of the Evaluation

2.4.1 Context

In nature existence of both man and elephants is necessary and the same is recognized in the Constitution of India. India has an estimated elephant population of about 29, 964 as per census 2019 as a whole, a geographical area of about 109,500 sq.km is available for the elephants. The southern states of Karnataka, Tamil Nadu and Kerala put together has about 44 percent of Country's Elephant population.

Karnataka has an estimated elephant population of 6,049 constituting about 22% of the country's elephant population and is a pioneer in protection of elephants in wild through various conservation measures of its habitat and declaring Elephant Reserves and numerous Protected Area Networks.

It is estimated that, on average about 350 people will be killed due to HEC per annum. Further, crops are damaged in an area of about 330 sq.km peryear.

Karnataka Forest Department (KFD) puts sustained efforts to mitigate and minimize the conflict and reduce the damage on both sides– human and animal as elephants also getting impacted by direct killings and indirectly through degradation of their habitats. The State Government is offering relief packages to the affected persons for both - life and property. However, measures in terms of crop compensation and damages to the assets are seldom satisfying.

In spite of various measures taken by KFD, total number of elephant raids and compensation cases are rising steadily over the years.

In order to mitigate the conflict, KFD is setting up a variety of barriers. Generally, any one type of barrier is erected and in some special cases due to increasing incidence of wild elephants straying out frequently, combination of barriers is also adopted. To complicate further, forest boundaries are long, traverse in different directions and across different terrains and often diffused.

On an overall perspective, the landscape of the entire evaluation study area can be brought under three categories to consider different type of barriers and various measures taken up

to mitigate the conflict and suggestions thereof.

1. Terrains and areas which are flat and plain (major portion) as seen in districts of Ramanagara, Hunusur, Mandya and parts of Mysuru. Here the forest is fragmented with diffused boundaries and mostly interspersed with agriculture and human habitation. In such areas it would be difficult to have barriers for small land parcels and effectiveness of the barriers in such areas needs to be evaluated. In such cases the effective measures to mitigate the conflict needs to be examined.
2. Second category is the flat terrain and plain and continuous forests and its hard boundary interfacing with villages as seen in Chamarajanagar and parts Mysuru districts of Bandipur, Nagarahole areas. Here the type of barriers erected and their effectiveness in reducing the conflicts needs to be evaluated.
3. In hilly and undulating terrain and forests interspersed with plantation crops such as Coffee as seen in Kodagu district, the adoption of measures is different as per the physiography of the area.. The type of barriers erected and its effectiveness in reducing the HEC needs to be evaluated in such cases.

   Considering the five districts under study are having mostly these three above mentioned landscapes, an effort will be made to categorize the elephant habitats in to these three and then addressing the issues of conflict and suggesting measures thereof would give a meaningful output.

2.4.2 Objectives

One of the main objectives of the evaluation is to map the details of the boundary barriers already erected in the study areas. Classifying them into different categories and combinations and assessing the cost of construction and their deterrence abilities will give an idea about the cost benefit analysis of these barricades.

Main indicators of Human Elephant conflict are number, type, frequency and distribution of crop raids and seasonal and temporal occurrence of these raids. Collecting these indicator data and analyzing them will enable to understand the underlying reasons and pattern of human elephant conflicts. The inference will also give probable solutions or suitable measures to mitigate the conflicts. Many of these

underlying reasons could be man-made, ranging from policy level to operational, illegal encroachment of elephant habitats to implementation of various programs. At the same time the some of the aspects such as carrying capacity of the forests, changes in the behavior pattern of elephants, status of elephant corridors needs to be examined.

However, in the past decade or so and now, using physical barriers which started with Elephant Proof Trenches (EPT) have been assisting in managing the man elephant conflicts to varying degrees. Gradually use of solar fences both ground and tentacle type, rubble stone walls and eventually Railway line barricades are in practice in different terrains either singly or in combination. In many cases EPT's may be effective in barricading the elephants moving into agriculture areas and in some cases, it could be Solar fencing or combination of both. But maintenance of these barricades is very important as much as their construction, otherwise it will be rendered ineffective.

As per the TOR following are the objectives of Evaluation Study:

- To study different kinds of barriers erected in the study area in the past two decades – proportion of forest boundaries covered.
- To assess effectiveness and efficiency of different types of barriers.
- Assess the quality of work in sample locations.
- Lifecycle of barriers and reasons for failure in general and specific to locations.
- Find out the most effective single or combination of barriers which can contain the wild elephant raids and reduce the cost of compensation.
- Find out other complementary measure which can be taken for mitigating the conflict.
- Examine any effective barricade models adopted in different states for possible adoption.
- Cost benefit analysis of different barriers in terms of crops saved and compensation reduced.
- Estimate optimal investment in barriers that result in minimizing the human elephant conflict.,
- Estimate budget requirement for covering the remaining forest boundaries with effective barriers in the next five years in the Study area.

- Identify the high, moderate and low risk areas for suitable barricading.
- Assess the need and functioning of different types of barriers in other states and country based on review of literatures.

The Evaluation Study is being carried out to meet all the objectives specified in the ToR.

Chapter – 3 : Review of Literature and Evaluation Methodology

3.1 Review of literature

Elephants are known once ranging across America, Europe, Asia and African Continents, but now confined to Asia and Sahara in Africa. International Union for Conservation of Nature (IUCN) has observed that the present Asian elephant (*Elephas maximus*) as endangered and African savanna (*Loxodonta africana*) and forest (*Loxodonta cyclotis*) elephants as vulnerable (IUCN 2017)

The population of Asian elephants is estimated at 41,410 to 52,345 individuals scattered among fragmented habitats in 13 range countries in Asia, and currently occupying 5% of their historic geographic range (Sukumar, 2006).

The population of African elephants is much larger; estimated at 550,000 to 700,000 individuals living in 37 range countries in sub-Saharan Africa. Yet more than 70% of the geographic range is unprotected and poaching for the illegal ivory trade continues to decimate Africa's elephant populations (Chase *et al.,* 2016).

With India being the only country with largest Asian elephant population at 29, 964 and the State of Karnataka having the distinction of having the highest population of elephants among the states in the country at 6094 (Elephant Census, 2019) and is an achievement from the elephant conservation angle. However, this has another concerning side in the form of Human Elephant Conflict (HEC). Human elephant conflict is not a new phenomenon and has been existing earlier also in the form of crop raids (Nelson *et al*, 2003). Even in Karnataka the conflict is not new, way back in 1822 in Kodagu the *ryots* complained about crop raids and damages to houses (Anon.2012). But of late, the subject of human elephant conflict has been on the increase and drawing more attention. The conflict started increasing somewhere in the 80's but was within manageable limits with enough food and water available in the natural habitats. Thereafter it is on the rise and assuming considerable magnitude. If you take the case of conflict in another elephant rich state of West Bengal, elephants in the Dalma Wild life Sanctuary were confined to Dalma hills as food and forage was available.

Subsequently with cultivation of crops like Paddy and the migratory habit of elephants resulted in crop raids and conflicts (Ganesh & Sanjana., 2019).

Human elephant conflict has been a major conservation concern in elephant countries. Despite trying to adopt several methods to mitigate the conflict, the problem persists mainly because most of the solutions are site specific and short- term ones (Shaffer *et al*, 2019) Elephants are known to consume fresh fodder to an extent of 8-10 % of its body weight on a daily basis. They also need plenty of water not only for drinking but for bathing and wallowing. Often considering the herds and the habitat richness, they move to larger areas in search of these primary needs. Studies conducted on the ranging pattern of elephants have shown that the annual home range of a herd is anywhere between 300-1000 Sq. km (Anon.2012). This inclination of elephants for feeding on crops has brought a direct confrontation with humans. There are several factors which are the underlying reasons for human elephant conflict.

Habitat loss and degradation due to changes in the land use is one of the major underlying reasons for the HEC. Conversion of elephant habitats into agriculture areas and habitation results in shrinking of elephant habitats and coupled with this, the increase in population of elephants puts more pressure on these shrinking resources (Chowdhury, 2004, Anon, 2012). The extent of range of Asian elephant declining to 500,000 Sq. km from 9 million Sq. km is also one of the main factors for the conflict today (Desai & Riddle, 2015).

Studies in Keonjhar forest division has shown a sharp fall in the elephant population from 112 elephants in 2002 to only 40 elephants in 2017. The decline in the elephant population is attributed to devastated and fragmented landscape, resulting in elephants leaving their native home range to stray into other regions Between 1989 to 2016, 13.7% of the total forest cover in Keonjhar forest division had been lost, mainly due to mining, agriculture and developed areas resulting in escalation of HEC (Tripathy *et al.* 2021).

It is reported that as many as 301 elephants and 1,401 humans lost their lives in the last three years of 2018-98 to 2020-21 due to human-elephant conflict. A total of 115 elephants died in 2018-19, 99 in 2019-20, and 87 in 2020-21. The number of humans

who died during the same period was 457,585 and 359, respectively,

It is observed that elephants across Asia live in variety of habitats and landscapes including on one end large scale contiguous forest tracts adjoining cropped areas and on the other end, degraded areas interspersed with agriculture and habitation in the fragmented landscape in a mosaic pattern with field crops and plantations. The pattern of crop raiding and reasons for the raids may vary. Elephants may prefer feeding on crops when compared to wild forage because of their higher nutritive content and palatability and also availability in one source. Studies on Asian elephants living in contiguous compact habitats show that not all elephants in a population raid crops. But in highly fragmented landscapes, the entire population may be involved in raids and Human elephant conflict. Due to the direct Human elephant conflicts, elephants also suffer indirectly by way of degradation of habitat and loss of forage. (Anon .2021)

Farmers in parts of Sri Lanka were making a move to expand agriculture by encroaching in Dahaiyagala WLS in Sri Lanka's Uva Province. The farmers entered the area aiming to clear the forest and take up cultivation (Rodrigo, 2021).

India accounts for 70-80% of all recorded human deaths due to elephants in Asia, around 500,000 families are impacted by conflict with elephants every year across the country, mostly by the animals damaging their crops. Between 80 to 100 elephants are killed by human-related activity each year, due to some from retaliation acts like poisoning or electrocution, others from being run over by trains (Pfeifer, 2021)

Fragmentation of habitats due to unplanned and diffused developments has also resulted in varying degree of conflicts (Desai & Riddle, 2015). As the elephants are used to their long ranging habitats, fragmentation of habitats has resulted in increased chances of contact with crops and cultivated land and the conflict (Anon, 2012).

Crop raiding by elephants is known to be high-risk foraging behavior especially by male elephants compared to females. They tend to travel quite a distance to get their nutrition and resulting in conflicts. (Pokharel, Singh & Sukumar, 2018).

Crop depredation is regarded as the stimulus of HEC. Understanding the issue on aspects of how, when and where crop raiding occurs will help wildlife managers to tackle and manage the hotspots of conflicts, and protect livelihoods of people and

implement appropriate mitigation measures. Conflicts usually occur at night times,with peaks during dusk and dawn. Crop raiding is generally seasonal and occurs within the periphery of PA's (Naha *et al*, 2020).

Abundance of elephant population in certain areas or in excess of carrying capacity is another factor of conflict. Compressed populations in fragmented areas where the densities are much more than what the habitats can take also results in conflict (Desai & Riddle, 2015). This has resulted in poor habitat quality and eventually pushing the herds into human interface and increased conflicts.

Elephant behavior links directly to habitat and elephant population. Considering the social structure of the herd, adult male and sub adults express the behavioral pattern of crop raiding (Anon, 2012.). Elephants are known to have well defined home ranges and migration routes mainly based on food and water and important to consider raiding and non-raiding clans to manage the HEC.

Habitat factors such as availability of water is one of the deciding factors of elephant distribution. Herds prefer to stay closer to water sources. Different forest types also is a factor which decides the distribution of elephants. Adverse factors such as droughts will also result in herds trying to find better habitat outside their range resulting in conflict.

Factors related to human are also one of the reasons for the conflict. Agricultural activities near and around elephant habitat results in crop raiding by elephants. Such frequently raid prone areas need to be identified and measures taken in advance to prevent the damage due to conflict.

With the legal frame work of Wildlife Protection Act (1972) in operation, emphasizing the protection of elephants ensured that the elephants are protected. Habitat protection outside the PA's was not considered and in the absence of clear cut policy of overall perspective of elephant and habitat protection and conservation, there is much confusion on the populations outside the PA's. However, with this, elephant population increased and there was pressure on its habitats due to its loss, fragmentation and degradation. This method has resulted in increased conflicts. In order to overcome these conflicts as immediate remedial measures, the approach was symptomatic in the form of preventing the elephant – human contact through barriers and other measures

rather than looking into the underlying causes (Anon, 2012). The underlying causative factors such as habitat loss and fragmentation have already happened and there will be minimal scope for setting right these by way of management actions such as enriching the habitat and identifying the corridors and restoring it to the extent wherever possible.

Understanding the elephant behavior and the reasons for the increased conflict will help in devising appropriate mitigation actions specific to the area (Desai & Riddle, 2015). Damages due to elephant raids results in eating the crops as well as trampling. Considering the types of raids by the elephant, some of the situations could be as follows.

About 22 percent of the elephant habitat is found in the PA of the country, with the remaining population residing outside and coming across human interaction. The estimated 29, 964 elephants are distributed in 3 percent of the geographical area of the country. On an average 350 people are killed due to the conflict and about 330 Sq., km of area is crop raided annually during 2008-10. About 40-50 elephants are killed annually due to conflict (Lenin Janaki, 2011).

3.1.1 Types of raids: Opportunistic crop raids generally occurs in agriculture areas around the elephant habitats and where there is hardly any protection for the crops and elephants perceive the agricultural crops as a concentrated source of food. In these cases, providing guarding and minor barriers will effectively bring down the damages. However, often the opportunistic raid habit will continue and become habitual raiders and then the severity of conflict increases. These have to be treated differently as the elephants have lost the fear of human beings and see the crops as an easy source of food and can circumvent the usual methods of protection and can negotiate the barriers. These raiders eventually become obligatory raiders with their persistence. The obligatory raiders evolve due to inadequate food and water in their home range and dependent on crop raids for their survival. Habitat loss and degradation reduces the size and quality of the habitat in the home range and the elephant's only survival mode is to raid the crops. Dispersing populations of elephants often cause severe conflicts and need to be addressed separately. The extent of damages to crop depends on the severity of habitat loss and the inadequacy of resources in the habitat. These are difficult to manage and mitigation actions have to be well thought of not usual temporary measures (Anon, 2012.

Desai & Riddle, 2015).

Addressing the interface of forest boundary with villages need to be taken into account while planning for mitigation measures. Clear boundaries between human usage areas and elephants will usually have less conflict and the boundaries itself will act as barriers. Crop damages and compensation thereof is considerably less. Many of the PA's will have this kind of clear boundaries. In another scenario, diffused boundaries and small fragmented patches of habitats interspersed with agricultural crops and human habitation resulting in frequent encounters with humans and conflict. Mitigation measures with barriers in these scenarios would be difficult as there is no clear boundary where they can be implemented. The human elephant conflict is prevalent in most of the elephant habitat and human interface areas and most of the strategies to prevent the conflict are site specific and offer only short-term solutions and the mitigation strategies transfer the conflict from one place to another (Shaffer, *et al*, 2019).

Elephants gets attracted to the crops as they are more palatable and have less defenses than wild plants, in addition they may also be nutritious due to breeding and fertilization. It is observed in few cases that young oil palms are a favorite, especially those aged between two and four years. Males are known to engage in high-risk activities like crop-raiding, which may be a means of increasing their reproductive potential through better nutrition. They are also more likely to break fences, including electric fences, as their tusks do not conduct electricity (Chong Kah Fui & Dayanag Awang Ali Bema, 2005).

3.1.2 Elephant - Human Conflict mitigation measures: As a long-term measure, it is important to find out the underlying cause of the conflict in any area and tried to address this. In areas where this is not possible for various reasons, efforts to minimize the conflict can be taken up with several other temporary measures such as barriers and deterrent measures so that the conflicts do not escalate or new conflict situations occur. Though the long-term measure will ensure reduction in conflicts and compensation thereof, it is not possible to address fully most of the times. However, efforts are to be made to identify the causes of conflicts and whether there is a possibility of reversing the causes and then finally mitigate the conflicts with other measures (Anon, 2012).

As part of long-term measure, restoring habitat loss though essential, socially and economically it may not be feasible. In such a scenario, only some of the critical areas need to be approached for restoration. With sustained efforts encroached areas in the elephant habitat must be recovered.

3.1.3 Habitat loss: large scale restoration of habitat is socially and economically not feasible and, therefore, only critical and extremely essential areas should be targeted for restoration. For this there is need for clear assessments to justify reasons for purchasing such areas. a. One important means of restoring habitat is through recovery of encroached forest land within elephant habitat. Special efforts should also be made to identify such encroached lands that adjoin elephant habitats. As far as corridors are concerned though it may be difficult to retrieve them wholly, recently fragmented ones which are still used by the elephants may be restored after examining the same.

The interface of forests and areas used by human beings is always critical area for conflicts. Two pronged efforts are made to restrict the entry of elephants to such areas and also compensate for the loss of crops, property and lives adequately.

Managing the "Elephant Reserves" in the country which are elephant habitats outside the PA's is being done with support, funding and management to conserve elephants (Desai & Riddle, 2015)

Habitat fragmentation is one of the reasons for the conflict and it is necessary to identify such fragmented patches and establish connections between them. As elephants depend on their home and seasonal ranges for their movement between patches, identifying and protecting such corridors go a long way in conserving the habitats of elephants without conflict.

Addressing conflicts and interface of elephant habitat: It is important that the underlying causes of HEC have been identified and addressed. Even then in the interface the HEC persists. Fragmented landscapes and diffused boundaries increase the conflict. Clear boundaries between human and elephant interface will reduce the conflicts and enable better crop protection methods. Type and length of interface will decide the HEC management practices, the cost involved and the intensity of the conflict and effective protection of crop and property and lives thus influencing the

compensation costs.

The study shows the risks associated with the identified hotspots which in turn helps to maximize the effectiveness and minimize the cost of HEC management, by ensuring efficient resource allocation to these hot spot zones. It is important to identify the hotspots for different types of HEC which helps in devising streamlined compensation policies, whilst expanding the scope of mitigation measures. For instance, human casualty hotspots can be prioritized over property or crop damage hotspots when mitigation funds are scarce, as the cost of human casualty precedes cost of property or crop damage (Tripathy *et al,* 2021)

There are various methods which change the interface and reduce the HEC. Some of them are, alternate crops not preferred by elephants such as chilly, citrus, but this depends on the socio-economic aspects of the grower. Altering the land use in the interface area by using it for non-agricultural uses also reduce the HEC. Removing the interface by shifting the agriculture another area and also trans locating the elephants are the other possibilities with limited practicality.

WildEyes, an AI system has developed a tiny camera imbued with artificial intelligence that can be trained to recognize specific animals in the field. The first version of WildEyes is trained to recognize elephants, which often come into conflict with humans when they raid crops and enter villages. WildEyes can sound an early alarm to help prepare villagers to repel elephants. The best use of WildEyes appears to be the fact that it will help in avoiding the element of surprise, this would potentially allow local wildlife managers or village guardians to be ready with humane deterrents (Geib , 2020.)

The issue of over population in a site either due to reduced habitat and compressed population and the carrying capacity of the habitats needs to be studied carefully and then to be addressed. Over populated numbers coupled with degraded habitat will result in increased HEC.

The conflict still persists in the interface and needs to be mitigate and various tools and measures are available for the same. Measures such as guarding, patrolling, deterrents and barriers form the core which has been resorted to reduce the conflict. Among the

various traditional methods, guarding is an old method when farmers and communities have used to protect their crops by guarding and patrolling them at night from elephants and other wild animals. Guarding with other crop protection tools such as electric fences, elephant drives will supplement the effect and deter the conflict (Nelson, *et al,* 2003. Desai & Riddle, 2015. Anon, 2012). There are few methods such as Noise, Fire, Projectiles, stones; odors are being used to drive the elephants once their presence is known. Cleared field boundaries, decoy foods are some of the other methods used. Some of the disturbance methods employed are, lights, thunder-flashes and flares, trip wire arms, driving vehicles (Nelson, *et al,* 2003).

Repellent methods affecting the olfactory and auditory have been tried and have given mixed results often acting as deterrent. Among these, Oleo – resin capsicum spray, chilly grease on barriers, burning repellents, elephant pheromones, elephant distress calls are being used with mixed responses in various places (Nelson *et al,* 2003. Desai and Riddle, 2015. Shaffer *et a*l, 2019).

Beehive fences, surrounding crops fields with beehives attached to fence posts and strung together with wires may serve as a humane and eco-friendly way to protect crops from elephants. Repeated farm-level trials have demonstrated benefits to farmers of using beehive fences, including fewer elephants approaching their fields and, for communities willing to manage the bees, production of "elephant-friendly" honey (Thomasy, 2019).

3.1.4 Physical barriers: Conflict mitigation has focused much on separating the elephants from the humans by adopting various methods. Physical barriers enable this separation and act as an obstacle to the elephants from entering the cropped areas. Use of thorny bamboo fencing, other thorn fences, hedgerows have been tried. Often these act as psychological barriers to the elephants. Over a period of time, barriers have been developed which are capable of preventing the elephants from entering the agriculture fields. Among these, Electric fences, Elephant proof trenches, rubble stone walls, solar fences and of late railway line barricades are being used with mixed results (Nelson *et al,* 2003, Desai & Riddle, 2015, Anon, 2012, Shaffer *et al,* 2019). But one need to look into the cost benefit analysis of erecting such barriers, as often the expected results are not met (Nelson *et al,* 2003).

Use of bio fences with agave, citrus plants, Palmyra are known to deter the elephants from entering the crop areas. However, these are mostly practiced by individual farmers surrounding their agricultural fields rather than surrounding the entire village. Another aspect is to weigh the cost involved in raising the bio fences and their maintenance over a period of years and the benefit derived from these barriers (Desai & Riddle, 2015).

Other physical barriers mostly used are rail fences, rubble stone walls, and are being used in specific sites on a limited scale and in areas where cases of conflict are severe as the cost of erecting rail fences is expensive. Some of these barriers are either used singly or in combination for effective prevention of entry of elephants.

Elephant Proof Trenches are effectively used in certain site-specific areas as a physical barrier. Although they are expensive, if maintained properly can act as an effective barrier, construction and long-term maintenance cost needs to be looked into compared to the benefits derived. Stabilizing the trenches with cement, vegetation and preventing the erosion improves its efficiency. It is important to identify areas such barrier can be used effectively and not uniformly adopted (Nelson *et al* 2003, Shaffer, *et al* 2019. Desai & Riddle, 2015)

While erecting any of these physical barriers, it is important to arrive at a cost benefit analysis as the cost involved in construction and erection of some of these are expensive. In addition, if they are not maintained on a long term, their effectiveness will be lost. In certain sites, single barrier may not be effective, a combination of barriers may have to be used and cost, availability of funds and benefit derived could be a deciding factor in such cases.

Physical barriers such as trenches, electric fences as a method to exclude are commonly used to deter elephants from entering agriculture land and human habitation. This involves high costs both for construction and long-term maintenance thus limiting its large-scale application, especially in fragmented landscapes withhigh interface of forest and agricultural lands. Its effectiveness also depends on design, fence breaks by animals. Studies show that once African elephants learn that their tusks do not conduct electricity, they may use their tusks to break an enclosing electric fence, resulting in costly damage to the fence. Physical barriers also negatively affect long-term survival

by further isolating already fragmented elephant populations, disrupting movement, and access to seasonal food and water resources, and impeding gene flow between herds (Shaffer *et al*, 2019).

3.1.5 Compensation: One of the first reactions of a person who has lost his crop/property due to elephant damage is to seek compensation. This being an emotive issue, the demand for it overshadows discussion about any other measures (Nelson *et al*, 2003). Compensation can in the form of direct payment for any damages to crop, lives, and property as a result of HEC. While this is the form of support, there are several factors to be taken into account whether it satisfies the person who has been affected or not. Another form could be an indirect one by way of providing livelihood and encourage community participation in elephant conservation (Desai & Riddle, 2015). Compensation cases have not been very successful in terms of HEC as they are mostly addressing the effects rather than causes. Procedural problems such as delayed and low payments, not covering all claims, unequal disbursement, cumbersome and inability to quantify some socio economic and opportunity costs (Nelson *et al*, 2003. Desai & Riddle, 2015).

The success or failure of HEC management depends on the government and people's approach towards it. No solution can be totally effective in stopping the conflict; it is only to keep it under manageable limit. To make the both the stake holders understand the limitations of the HEC management issues, proper understanding of the problem and effective implementation through an appropriate tool is the order of the day. In this regard, capacity building, cooperation by communities and creating awareness and the resource availability in terms of finance goes a long way in successful implementation of the conflict mitigating efforts.

In a study in Kerala where about 17, 216 cases of compensation were registered with Kerala Forest Department from 2019-2015. Elephants accounted for 48 percent of the cases indicating the man-animal conflict is dominated by elephants (Ghosh, Sahana, 2020)

The study finds that districts with high HEC were also the ones in which the highest number of compensations claims against wildlife damage had been registered. Higher

conflict was reflected both in the number of cases that were registered against elephants in these districts as well as the amount of compensation paid for elephant damages. Elephants were also among the top three wildlife species causing damage in all the districts except one, the analysis revealed (Ghosh, Sahana, 2020)

A landscape approach to conservation and reduction in human-wildlife conflict is emphasized in India's National Wildlife Action Plan (2017-2031). Its further reports that pooling this data from multiple years and map the distribution of these compensations, it provides a valuable information including where the conflicts happening and which clusters reported maximum damage (help identify conflict hotspots), animals and group size, crop types damaged, seasonality of damage, mitigation measures used in those areas (and the success of those measures) and other information.

The researchers have found no relationship between the number of cases reported and rainfall in Kerala, which is in contrast to the observations around the Nagarahole National Park in the state of Karnataka where compensation data revealed that conflict frequencies were highest during August–November, a period when there was a decrease in rainfall and important crops such as finger millet, maize, and paddy were ripening. This finding is similar to that of Chen *et al.* (2016) in China, where they reported that HEC became more intense during the rainy season when crops such as paddy, corn, beans, peanuts, and sugarcane matured (Ghosh, Sahana, 2020).

According to the government's Elephant Task Force, 2010 report, more than half of the expense incurred by Project Elephant under the 10th Five Year Plan (2002-2007) was for HEC mitigation. Another 15 to 20 percent was spent on ex-gratia and compensation for loss of property or crops. More than two of every three rupees spent on elephant conservation directly or indirectly deals with HEC. Many farmers do not even file claims because the compensation (or ex-gratia as it is called) paid does not match the market value of the crop/livestock/infrastructure loss and the transaction cost incurred to avail of this ex-gratia is quite high. Lack of uniform methods to measure the crop damage due to elephants is another issue and many times it depends on the evaluators. In some places, they take what is reported, in some cases, they do visual estimation and in others, they measure the length and breadth of the damaged

area and calculate the area. Many occasions people over- report as they are aware, the area will be reduced by evaluators. (Ghosh, Sahana, 2020).

Losses incurred have to be matched close to realistic market values and the payments have to be on time. People affected are not only physically deprived of their assets but also mentally affected and they need some sympathy.

Government of India has launched a National Portal on Human- Elephant conflict called "Surakshya" with the aim of collecting real – time information and manage conflicts on a real - time basis. It will assist in data collection protocols, datavisualization tools and data transmission. This was launched on August 12, 2020 on the occasion of International Elephant Day.

In Chhattisgarh due to mining the elephant habitats have been degraded and thus pushing the situation in to more conflicts through crop raids and human deaths. Several interventions by the Community along with the forest department such as "Hathi Mitra Da" a forest department and community supported program. Youth from the villages patrol the areas in forest department vehicles during nights and forewarn the people abbot elephants. At the same time escort stranded people and help in driving away the elephants. Another intervention is the real time monitoring of elephants through WhatsApp group by the department and shared to the villagers through the ranges to alert the villagers of the presence of elephants (Meshram, Kushagra, 2021).

The document released by Ministry of Environment & forest & Climate change includes several measures to be adopted for reducing the conflict including identification and monitoring of elephants in South Bengal. Other suggestions such as sending SMS alerts to forewarn of elephant presence. However, it is felt that these practices need to be evaluated further for its application on large scale and also work out cost benefit analysis and should be taken up wherever it is economical with reference to the extent of damage caused.

To mitigate the conflicts, it is important to strengthen the human-elephant coexistence through by active management interventions by the State Forest Departments, involvement of various stakeholders and sensitization and generating awareness in local communities of forest fringe areas. Many of these practices are already adopted by

various Forest departments, they are presented here in a table format (Anon, 2020)

Sl. No.	Practices	Details
1	Management practices: Habitat management & improvement	Developing and maintaining permanent water holes Use of solar power for operating borewells, Fodder management plantations Fire management to control HEC, Grass land management, Management of invasive species, Bamboo planting and restocking
2	Restricting elephants in their natural areas: Installation of barricades	Elephant Proof Trenches Tentacle fencing, Rubble stone walls Solar powered high electric fences. Community electric fencing, Bee hive fencing, Railway line fence, Bio fence, Chilly fences, Concrete barriers
3	Monitoring of Elephants	Radio collaring of problematic elephants Watch towers to track elephants, Use of drones
4	Strengthening and Securing Elephant corridors to manage HEC	Relocation of villages in the corridors. Securing elephant corridors
5	Driving back elephants to itsnatural habitats Repellent methods Deterrent methods	Use of fire crackers. Drum beating, Bee and Carnivore sounds, SMS alerts and WhatsApp network, Use of loud speakers, Trip alarm or sensory based alarm, Crop guarding, Chilly smoke,
6	Equipping of Forest Department Staff and Communities for HEC Management	High beam torches, Florescent jackets Equipped vehicles
7	Emergency Measures	Mob control to prevent casualties Ensure clear communication to filed officials Primary response team and Rapid response team Anti-depredation squads. Crop compensation and ex gratia for death.
8	Use of Technology	Early warning systems for undulating and flat terrains technology near Railway lines Cell operated flashing LED lights
9	Capacity Building and Awareness campaign	Capacity building for Anti depredation squads Training of Mahouts Training of Departmental staff Awareness programs Enlisting the involvement of stake holders

3.2 Evaluation Methodology and Sampling

3.2.1 Methodology

As mandated in the TOR, United Nations Norms will be followed as below while carrying out the Evaluation Study:

- Utility, Credibility,
- Independence, Impartiality,
- Ethics, Transparency, Human Rights,
- Gender Participation, Capacity and
- Professionalism

These norms will guide the process of evaluation.

On an overall perspective, the landscape of the entire evaluation study area can be categorized under the following three types to consider different types of barriers and other measures to reduce the conflict:

a) Terrains and areas which are flat and plain where the forests are fragmented with diffused boundaries and mostly interspersed with agriculture and human habitation

b) Flat and plain terrain with continuous forests and hard boundary interfacing with villages

c) Hilly and undulating terrain and forests interspersed with plantation crops such as coffee.

Following Evaluation Methodology has been adopted:

- Comprehensive review of the scheme, its history/genesis, scientific assessment of impact of different type of barricades in different conditions in reducing HEC.
- Review of secondary data and literature and also news items about the man – elephant conflict to understand the issues and measures taken by Government and Society to mitigate man elephant conflict and the outcomes of the measures
- Review and Documentation of formal and informal measures taken by Govt., local administration and society to mitigate the HEC and its outcome.

- Data collection on details of barriers erected by the Department under various schemes and mapping them - category wise, costs and deterrence capability based on the data provided by KFD.
- Data collection on number, type, frequency and temporal distribution of elephant raids and potential reasons for straying of wild elephants and its analysis from the selected sample villages.
- Collection of past data for five years on number of crop raids, injuries and deaths due to HEC, and wherever compensation was paid forms the frame work for the analysis
- Detailed study about maximum 10 cases of raids in sample villages which were selected randomly, through interview schedule of affected persons in the villages.
- Testing of Hypothesis to find out whether the study results are in agreement or not with the original hypotheses derived from other researches or similar studies.

3.2.2 Sampling

A. Sampling of barriers

As per the data available from KFD, a total of 5037 kms. of different of types of barricades constructed during the study period of 2014-15 to 2018-19. As per ToR 10% of the length of these barricades were covered in the sample at different locations.

The verification of physical barriers or barricades covering the five districts depending on the type of barricades is sampled at 10 percent sampling as follows:

Type of barricades	Total length (km) covered during the period of evaluation	Sample length (km) to be verified at different locations
EPT	781	78
Solar	1424	142
Rubble Stone Wall (cu.m)	2749	275
Rail Fence	84	8
Total	**5037**	**503**

Barricades have been checked for the following aspects:

1. Type of barricade
2. Year of construction and maintenance period if any
3. Cost of construction
4. Average life of the barricade
5. Status of the barricade as in 2020-21 (current) whether maintained or not maintained, abandoned, and reasons for non-maintenance, its deterrence abilities.
6. If the barricade is damaged, whether it is repaired in time or not, if not reasons for the same, whether funds were the constraints or man power

- As part of study a total length of 503 km. of barricades of different types were studied as indicated in the above table.
- Sample barricades were selected through stratified random sampling technique in sample villages giving due weightage to the facts like villages nearer / away from forest, density of forest, availability of each type of barricades, frequency of raids / damages.
- As per data collected from Division Level Offices of KFD, 128 villages were affected by elephant raids during the study period / located adjoining to barriers / forest boundaries in the three districts.

B. Sampling of villages

Out of the total affected villages with varying intensity of conflicts, 10% of the villages to be sampled after identifying them based on the maximum number of crop raids. KEA has provided the list of all villages for sampling purpose. The distribution of the villages for sampling is stratified as follows:

District ⟶ Taluk
↓
Forest Division
↓
Range
↓
Village

The criteria for selection of sample villages are based on the data on total number of villages adjoining forest boundaries and are also having maximum depredation cases in each of the forest Range, under Forest Divisions and District. In addition, whether these forest boundaries have barricades to mitigate HEC were also taken for consideration. With these criteria, the total number of villages in each of the district, forest range wise and division wise was the population for selection of sampling and then 10 % of the villages are selected out of this.

- As per ToR 10% of villages were covered for the study and accordingly following 128 villages were covered under the study in five districts. Table shows the villages covered and number of farmers visited in the Forest Divisions.

Table showing the selected villages and number of farmers visited Division wise :

District	Forest / Division	Number of selected villages	Number of affected farmers visited
Ramanagara	Ramanagara	26	191
Mysuru	Mysuru	14	47
	Hunusuru	5	9
Chamarajanagar	BRT	6	25
	MM Hills	10	55
	Cauvery	6	75
Mandya	Mandya	6	19
Kodagu	Madikeri (T)	12	93
	Madikeri (WL)	5	48
	Virajpete	4	35
	Bandipur	17	107
	Nagarahole	17	150
Total		**128**	**854**

- In each of these sample village, maximum of 10 cases of depredation and compensation paid for different purposes (like crop raid / property damage/injuries/death) were examined through structured questionnaire. The types of compensation for sampling will be selected on proportionate sampling technique. A draft questionnaire was prepared and tested in the field during Pilot Study and the Questionnaire was fine-tuned and enclosed at **Annexe-2.**

- During the interview of respondents or persons who have suffered themselves in person, their efforts to mitigate, support received (or not received) from the Forest department,

society / state / district administration was collected as indicated in the questionnaire.

- Further, interviews were also held with the members of society / village where HEC exists in order to gather information on their suffering and support received (not received) from the forest department, society / state / district administration. Minimum of two such interviews were held in each sample village. These interviews were conducted with the aid of a structured Discussion Points as enclosed at **Annexe-3.**

- In addition, interaction with different levels of officers in Karnataka Forest Department were also held to elicit their perceptions / experience and document thesame. In order to capture the outcome of interaction, an interview schedule as enclosed at **Annexe-4(1), 4(2) and 4(3)** was used.

- Apart from individual / Group Interviews, ten Focus Group Discussions (FGD), with two in each of the five districts were conducted. Out of two FGDs one each was held with affected members and knowledgeable persons in these five districts. Interview schedule as enclosed at **Annexe-5** was used to elicit the information from these FGDs.

- In addition to district level FGDs, 30 - In Depth Interviews–5 each with district level officers in the five study districts and 5 with state level officers at Head Quarters, with the help of interview schedule was organized (enclosed at **Annexe-6)**.

- Data collected during field study, interviews, FGDs etc., is being compiled, processed, validated, analyzed and is used in preparation of evaluation report.

- Case studies as a part of the study is being taken up with special / unique featuresas part of the assignment and is presented in the Report.

- Apart from the structured questionnaires, important information pertaining to various ongoing activities and events at field level were also collected during discussions with field level officers and brought out in the report.

3.3 Limitations/ Constraints in the Study

Following are some of the limitations/constraints:

a) The evaluation has to be on forest administrative circle or division wise rather than district, as there is overlapping of forest areas in districts

b) The approach could have been landscape based rather than administrative districts

c) Other elephant habitats of Chickmagaluru and Hassan have been left out.

d) Data collection from the Sampled villages and the actual incident has a time lapse between the incident of crop raid and data collection.

e) Effectiveness or efficiency of the barriers cannot be directly assessed as the sample villages selected are random and the barricades samples are independent of each other. However, selection of villages with barricades would have resulted in biased sampling.

f) Inspection of sampled barricades for their Status is being done with a time of gap of 5-6 years.

g) Detail data of two decades range - wise are not available at Field Offices.

h) As many of the barricades may not be in working condition after few years (unless maintained) suggesting measures in such cases will be of little or no use.

i) Cost benefit analysis of individual barriers and arriving at the optimal cost cannot be made with the present sampling of villages and barricades, as they are independent of each other. A different approach for this should have been devised

3.4 Assessing reflections of study

Based on the exposure and findings during the Study a sample Log Frame Matrix is attempted as outlined below:

Objective: Mapping of EPT constructed in Shimsha Village to assess the deterrence capacity.

Verification: One kilometer of EPT being 10% sample is inspected and verified along with officials of KFD.

Assumptions: This EPT is expected to restrain elephant raids to the villages next to the EPT.

Outcome: Due to terrain of the forest, EPT was filled with soil and forest wastes and weeds and in some spots, elephants could cross the EPT and entered into village, damaging the crop and properties. This is because of lack of maintenance of EPT due to want of funds.

Suggestions: To make provisions for adequate funds for maintenance of EPT. Also, to create combination of EPT along with rubble stone wall in some of the spots to avoid land sliding and damage to EPT and elephants crossing over.

3.5 Estimation of Macro Level Picture

The sampling size for evaluation of barricades and for collection of data on crop raids are at 10%. It is presumed that the data collected at ten percent sampling can be extrapolated to macro levels. However, it is to be noted that the extent of sampling of various barricades though fixed at 10 % sampling, the actual sampling has been done higher than 10 %, the same has been brought out under Chapter-III (3.4.1). Hence, estimation at macro levels is possible.

Chapter– 4 : Findings and Discussions

4.1 Area of study

The area of study for this evaluation report comprises of major elephant habitat districts of Ramanagara, Mandya, Mysuru, Chamarajanagar and Kodagu. These districts have 12 Forest administrative divisions including Bandipur NP and Rajeev Gandhi NP (Nagarahole). Some of these areas or districts also borders with adjoining states of Kerala and Tamil Nādu and forms interstate elephant corridors and migratory routes. Each of these forest divisions have been covered to collect relevant data in line with the laid down objectives of the evaluation.

The main aspects of the data collection in these areas of study pertains to the various measures adopted in terms of barricades and their effectiveness in reducing the Human Elephant Conflict (HEC) and also the compensation paid in terms of ex gratia for the losses incurred by the affected persons. In addition, various complimentary measures involved and arrive at a single or combination of barricades and measures to reduce the HEC.

The following table shows the details of the 12 forest divisions and the 55 forest ranges covered under the study followed by details of the findings:

Table- 1: Details of the Area of study

Sl No	District	Forest Division	Forest Range
1	Ramanagara	Ramanagara	1. Ramanagara
			2. Sathanur
			3. Magadi
			4. Kanakapura
			5. Channapatna
2	Chamarajanagar	MM Hills	1. PG Palya
			2. Hongyam
			3. Hannur Buffer WL
			4. MM Hills
			5. Ramapura
			6. Kollegala buffer
			7. Palar
		Cauvery WL	1. Cowdalli WL
			2. Halangar WL

Sl No	District	Forest Division	Forest Range
			3. Gopinattam WL
			4. Kothanur WL
			5. Hanur WL
			6. Sangama WL
			7. Mugur WL
		BRT	1. Punjur
			2. Bylore
			3. Chamarajanaga
			4. Kollegala
			5. K Gudi
			6. Yelandur
3	Mysuru	Mysuru	1. Saraguru
			2. HD Kote
			3. Nanjanagudu
			4. Mysuru
			5. T N Pura
		Hunusuru	1. Periyapatna
			2. K R Nagara
	Mysuru & Chamarajanagar	Bandipura NP	1. N. Beguru
			2. Nugu
			3. Kundukere
			4. G S Betta
			5. Omakara
			6. Madduru
			7. Gundlupete
			8. Hediyala
			9. Moliyuru
			10. Gundre
4	Mandya	Mandya	1. Madduru
			2. Malavalli
			3. K R Pete
5	Kodagu	Madikeri - T	1. Bhagamandala
			2. Kushalanagara
			3. Madikeri
			4. Somavarpete
			5. Samapaje
			6. Shanivarasanthe
		Madikeri – WL	1. Srimangala
			2. Pushpagiri
			3. Talacauvery
			4. Makutta

List of villages affected due to HEC under these ranges and divisions have been collected from KFD. A total of 1108 villages were listed across five districts and 12

forest divisions and 55 ranges. As per the ToR a sample of 10% of villages, which totals to 110 villages to be covered in the study for collecting primary data on various aspects of HEC as per the approved schedules. However, with objective of giving due weightage to major forest ranges, a total of 128 villages have been selected as sample for detailed study. The sampling methodology and list of sample villages have been provided by KEA.

A map showing the area of study is shown below which shows a contiguous forest area and elephant habitat along with the adjoining states.

Picture- 1: Map showing the area of study

In line with the ToR, ten percent of the total barricades constructed during the study period was sampled after visiting each range. For collection of data on crop raid cases, village will be the first stratum based on ex gratia paid and crop raid cases. From each sampled village a maximum of ten affected farmers were visited and data collected from them. From a total of 128 villages 854 farmers who were affected have been

visited and data collected as per the Schedules.

The overall picture of the study area comprises of different landscapes. Categorizing these landscapes into different sub groups and placing the forest divisions in them will enable a better analysis and suggestions thereof. Thus, the entire evaluation study area is broadly categorized into three landscapes. This has been done keeping in view the short and the long-term measures to be evaluated and further suggestions to mitigate the HEC.

1. Areas with major portion of having flat and plain terrain, where the forests are fragmented and interspersed with agriculture and human habitation forming a mosaic pattern. Here forest boundaries are diffused and not clearly demarcated. Most of the villages are in close proximity to forests, Areas of Ramanagara district and parts of Mysuru, Hunusuru, and Mandya division fall under this category.
2. Areas with flat and plain terrain with continuous large tracts of forests and boundary interfacing with villages. The boundaries are hard and clearly demarcated. This type is seen in Chamarajanagar, Nagarahole and Bandipur NP.
3. Areas with hilly and undulating terrain with forests interspersed with coffee and other plantation crops as seen in Kodagu.

The above classification helps in analyzing the data for similar areas and problems due to HEC and also come out with suitable suggestions for reducing the HEC based on this classification. With this back ground of the above landscapes categorized in the study area, this report comprises of results and findings from districts of Ramanagara, Chamarajanagar, Mysuru, Kodagu and Mandya and are discussed in detail.

Of these areas, Ramanagara district is unique in the way that it involves almost all the challenging issues concerning HEC. With its dry deciduous forest type which is fragmented mainly on the hillocks and adjoining areas. This is interspersed with agricultural fields and human habitation presenting a mosaic pattern of forest and agriculture land use. In Channapatana taluk, with abundant water source, and commercial cropping pattern, coupled with these fragmented forests habitating

elephants is in itself a case study for the Human Elephant Conflict. As mentioned above, most of the Ramanagara district falls under the first category of landscape where in the landscape is mostly flat terrains and forest is fragmented and interspersed with agriculture and human habitation. The results and findings in this district will present a picture of the genesis of the conflict in such areas. The measures taken to mitigate the conflict and effectiveness and deterring abilities of various barriers used singly or in combination is presented. Further, what needs to be done to manage the mitigation has been brought out in the report.

District Mandya, mainly comprises of flat terrain and as it is located on the banks of river Cauvery, economy is mainly agriculture based with crops like paddy, sugarcane, cotton, banana and Ragi. The terrain is flat lands with Melkote range forming conspicuous peak. Forests are mainly dry deciduous and scrub type.

Mysuru District comprises of Mysuru and Hunusur Forest divisions. Both almost follows the pattern of Ramanagara as the forests are interspersed with agriculture and human habitation but to a lesser degree. Hunusur Division which is abutting the western ghats, has plain terrain with fragmented forests interspersed with agriculture and habitation. The district has an undulating land with rare mountain and some isolated peaks. The division is adjoining Nagarahole NP.

Chamarajanagar presents a different landscape as it has three Wildlife Divisions and has continuous forest areas and hard boundaries which are interfaced with villages. Most of the area is flat terrain and rain dependent farm lands along with forested hills. The district borders Tamil Nādu and Kerala. The HEC takes a different dimension here as the villages adjoining the boundaries are involved in HEC.

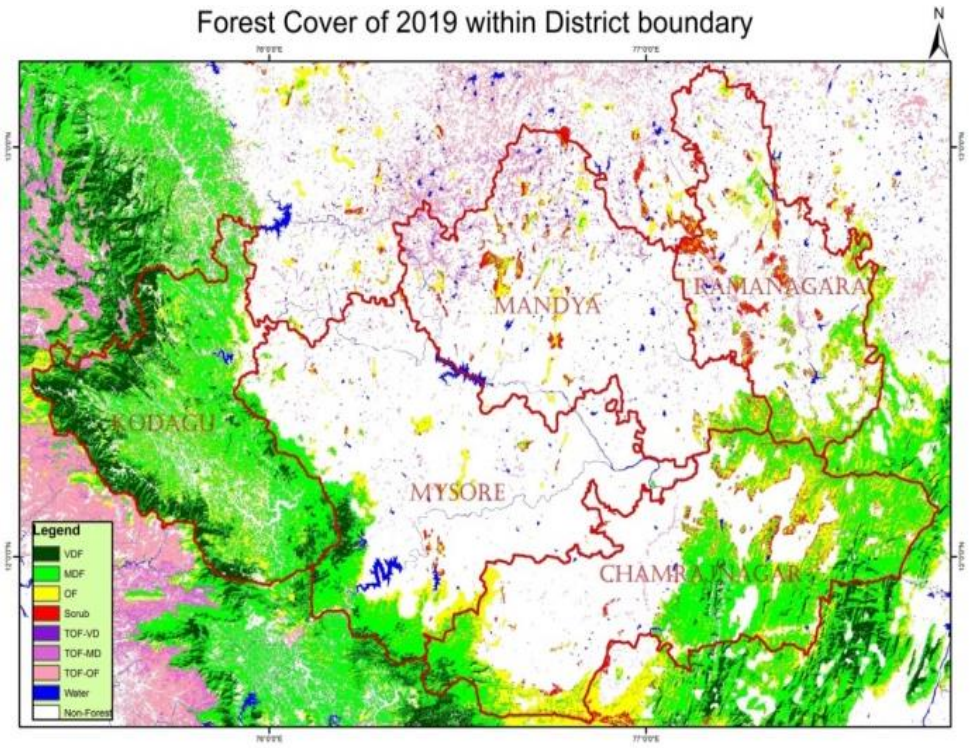
Kodagu is a well-known district for its diverse forests from dry deciduous to evergreen types and also hot spot of biodiversity. The district comprises of hills and valleys covered with forests on the slopes of these hills. Towards another part, the district has undulating plains. Coffee, pepper and cardamom as a plantation crop and paddy are grown in these areas. The district has three forest divisions, Madikeri territorial, Madikeri Wild life and Virajpete.

Bandipur National Park is a tiger reserve and the area falls both in Mysuru and Chamarajanagar district. Located in an area where Deccan plateau meets the Western ghats, it has both flat terrain and the altitude ranges from 680 to 1454 meters. It has number of villages on the fringes of forest boundary and movement of elephants and HEC is a common feature. Commercial crops like sugarcane are grown besides field crops like Ragi. Most of the forest are being contiguous with hard boundary, efforts are on to mitigate the HEC through barricades and other measures. Along with Mudumalai WLS of Tamil Nādu and Wynand WLS of Kerala it forms one of the largest biospheres in the country

Nagarahole NP is located on the foot hills of western ghats in Kodagu and Mysuru district forming part of the Nilgiris Biosphere. The area is a contiguous forest tract and has hard boundaries. Fringes has villages which often face the HEC due to movement of elephants.

A map showing Forest cover map and district boundaries of the study area is shown (in Map 2) given below:

Picture -2: Map showing the Forest cover and district boundary of area of study



This evaluation report covers five districts namely Ramanagara and Chamarajanagar, Mysuru, Mandya and Kodagu. The Forest divisions and the Forest ranges falling under these administrative districts are given in Table 1. These districts include forest circles and divisions which are traditionally major elephant habitats. The landscape of these areas includes the three different categories mentioned above covering diverse habitats. The data collected from these diverse habitats will give an insight to the genesis of problems of HEC and its magnitude. Various measures taken to mitigate the conflict and further ways to adopt and manage the conflict based on locality is also discussed.

Karnataka has one notified Project Elephant Reserve spread over 6463 Sq. km comprising of 15 forest divisions (Anon. 2012) also known as Mysore Elephant Reserve. This forms part of the larger elephant population extending to the adjoining states of Tamil Nadu and Kerala. Most of the study area falls under this purview. An estimated average population of 5740 elephants was reported in 2010 (Anon.2012) in 19 divisions spreading over 10,000 Sq. km of elephant habitat. This includes few divisions which are not under the purview of this evaluation study. In the population estimates of 2017, Nagarahole NP is having the highest density with 1500 elephants in about 843 Sq. km. Another study shows elephant occurred in 972 forest beats out of total 2855 studied, 55 % of this habitat is outside the PA' s indicating that the distribution is very much there outside PA (Madhusudan *et al*, 2015). Studies indicate that the distribution of elephants is more seen in primary moist deciduous forest with this vegetation type offering diverse and abundant forage with its gently undulating terrain to flat with water bodies. Some of the major PA in the state falls under the study area of the project. The major portion of Chamarajanagar district with its three Wildlife areas and almost 18 forest ranges form main part. Along with this, the Nagarahole and Bandipur PA's makes the major part of the Wildlife area.

4.2 Sampled Villages in Study area

Sampling of various barriers in these study areas are done to an extent of 10% in each category, however, in most of the cases it is more than 10% sampling. The methodology is explained under the chapter.

The selected sampled villages (methodology has been explained) were visited and the farmers who are affected and damages to crops, property, injuries to humans and animals and lives lost are shown in the Table 2. Data is presented from a total of 128 villages and 854 affected farmers for the entire area of study comprising of five districts have been collected and analyzed to arrive at relevant information on HEC. About 191 farmers in Ramanagara district and 47 in Mysuru District, 155 from Chamarajanagar district, 19 from Mandya district and 176 From Kodagu district have been visited to collect primary data. In addition, data from adjoining Bandipur NP of 107 and Nagarahole NP of 150 numbers were collected.

Further, classifying these sampled villages in the three categories as mentioned earlier, it is seen that the first category where forests are interspersed with agriculture and habitation with diffused boundaries and has more cases of HEC. Based on the landscape categories formed, out of the total 128 villages, 51 villages and 266 affected farmers forms the basis of data for analysis in this category. This forms about 39.8% of the sampled villages in this category.

The second category where the boundaries are hard and clear, the number of villages is around 56 with 412 affected farmers and this forms about 43.8% of the villages in the entire study area coming under this category.

The third category where the terrain is hilly and the forests are contiguous and mainly on the slopes and interspersed with coffee and cardamum. This has about 21 sampled villages and forms 16.4%. The number of affected farmers from whom primary data is collected is about 176.

4.3 Elephant population Density and further works

It is observed in the landscape categorized areas where there is interspersed forest with agriculture and human habitation, the conflict is likely to be high due to fragmented patches of forest of predominantly dry deciduous and scrub type, where there is a possibility of insufficient availability of forage and water coupled with this elephant population in the area also to be considered. Thus, the elephants may forage outside the habitat. Availability of agriculture crops on the forest fringes and nearby almost throughout the year due to irrigation and cropping practices is another reason for frequent elephant raids. With 414 Sq. Km of Forests in the district of Ramanagara altogether, an estimated elephant population of 251 (Anon. 2012), making the density of 0.61 per Sq. km of forests, conflicts are very much there. This data correlates with the information of overall average density of 0.6 per Sq. km (Anon 2012).

The question arises whether the habitat is able to support this density and whether these fragmented patches have the carrying capacity to sustain this population.

Mysuru Division has a total forest area of 160.37 Sq. Km and as per reports (Anon. 2012) it has an estimated population of 66 giving a density of 0.4 per Sq.km. Most of the forest type in this division falls under dry deciduous and scrub types.

The other district, Chamarajanagar has a different landscape category where in the forest and its boundaries are continuous and clear. However, the problem arises in interface of villages located on the fringes of the boundary. It has a sizeable forest area with 2756 Sq. km and an estimated elephant population of 1567 numbers and a density of 0.8 per Sq. km which is higher than the overall average density of 0.6 per Sq.km (Anon.2012). Probable reason for this higher density in areas like BRT, Cauvery and MM hills WLS, could be due to large tracts of secondary vegetation comprising of moist and dry deciduous forests (Anon. 2011). Most of the forest in this district are predominantly dry deciduous with scrub forest in the fringes. There are patches of moist deciduous, semi-evergreen, evergreen and shola forests in the higher reaches of BRT and MM Hills.

The elephant population density varies with the type of vegetation in the habitat. It is observed that dry deciduous forests in Ramangara district supports a density of 0.6 per Sq. km and this is normally followed by moist deciduous and dry thorny forests. The probable reason for high density of population in Chamarajanagar of 0.8 per Sq.km could be due to availability large tracts of forests of dry deciduous and scrub type as well as moist deciduous. It will be interesting to observe the population of elephants which these fragmented habitats can sustain. If the population is small, it may sustain but, if they are large, it may not sustain and competition among the herds may result in more conflict. Whereas the larger tracts of habitats like Chamarajanagar areas probably can sustain larger population. This particular aspect needs to be looked into and to be studied in detail. The data collected from primary source, is categorized into Data on barricades and Data on conflict and ex-gratia for presentation and analysis.

4.4 Data on Barricades

The project evaluates the status of the barricades and its effectiveness set up during the study period. One of the important basic data which needs to be looked into is the total barricades set up during this period and the forest area of the division and probability of reduction in HEC due to presence of barricades. The following table gives an idea of the total barricades set up and the extent of forest area in different divisions.

Table-2: Forest area and the extent of barriers constructed during the study period (2014-15 to 2018-19) across all types of barriers

District	Forest Division	Total Forest area (Sq. km)	Total barricades constructed (km)
Ramanagara	Ramanagara	414.54	9.86
Mysuru	Mysuru Division	160.37	40.10
	Hunusuru	136.36	16.42
Chamarajanagar	Chamarajanagar	2756.0	382.0
Mandya	Mandya	173.0	-
Kodagu	Madikeri (T)	389.14	111.45
	Madikeri (WL)	389.80	25.45
	Virajpete	303.48	9.14 +425 posts
	Bandipur	1020.21*	243.64
	Nagarahole	643.39	91.50

**Area includes both under Mysuru district & Chamarajanagar district*
Chamarajanagar includes the three divisions of BRT, Cauvery and MM Hills WLS

It is observed in all the areas of the study, as a short-term measure following types of barricades were constructed:

1. Elephant Proof Trenches (EPT) (old norms and improved ones),
2. Solar Fencing both on ground and tentacles,
3. Rubble Stone Walls,
4. Special structures in the form of RCC Pillars and posts
5. Railway line Barricades.
6. Combination of EPT and Solar
7. EPT with Rubble Stone Walls

The extent of forest area though indicates the need for more barricades, it is the nature of boundary the forest has will decide the length and type of barricades besides the severity of the raids. If the forests are fragmented or continuous then each needs a different approach. Mysore with a total forest area of 160 Sq. km has as much as 40 km of barricades constructed in the five-year study period. Divisions in Chamarajanagar and Bandipur has not only large forest tracts but many have contiguous hard boundaries requiring effective barricades to reduce the conflict.

It is observed that still sizeable length of EPT is taken up in most of the divisions followed by solar fencing. In divisions like Madikeri both EPT and solar have been taken up during the study period. Rail fence barricades have been on the increase in Bandipur division after 2015-16. Special structures such as RCC pillars and posts have been taken up depending on the site requirements and has been taken up in divisions like Madikeri, Hunusur and Bandipur. Pillars and special structures are taken up in Virajpete division. The rubble stones are mainly in combination with EPT to reinforce the main barricades and in areas depending on the site requirement. In contiguous forest boundaries and where it is well demarcated such as in Bandipur, Nagarahole and parts of Chamarajanagar, rail fence has been used. In Madikeri division, almost all the three types of barricades, EPT, solar and rubble stones have been constructed during the entire study period indicating the need for this measure and the increased HEC. Rail fence and solar has been on the increase in the last two

years of the study period in Bandipur, indicating the effectiveness of rail fence in managing the conflict.

4.4.1 Sampling of barricades

The evaluation starts with the sampling of the barricades constructed as shown above during the study period of 2014-15 to 2018-19. This sampling and evaluation of these barricades have been taken up during 2020-2021. A sampling of 10 % of the barricades were to be taken up a per ToR.

The details of the sampling of barricades from those constructed during the study period is shown in the following Table:

Table-3: Extent of sampling of barricades

District / Division	Total length of barricadesduring study period				Sampled barricadesduring study period				
	EPT (Km)	Solar (Km)	Rubble Stone (Km)	Railway (Km)	EPT (Km)	Solar (Km)	Combination of EPT &Solar	Rubble Stone (Km)	Railway (Km)
Ramanagara	1.86	8.00	-	-	1.8	3.0	-	-	-
Mysuru	9.30	30.80	-	-	3.0	9.0	19.0	-	-
Hunusuru	6.7	9.5	0.21	-	-	-	-	0.11	-
Chamarajanagar*	189.2	190.3	6.73		79.7	79.0		2.14	-
Mandya	-	-	-	-	-	-	-	-	-
Kodagu – Madikeri - T	81.04	29.25	0.16	-	17.3	-	-	-	-
Madikeri - WL					8.0	-	19.5	-	-
Virajpete	9.14	-	425** (posts)	-	5.0	3.3	-	-	-
Bandipur	177.7	33.50	1.50	30.95	23.2	10.2	19.4	46.7 Cu.m 0.13 Km	0.91
Nagarahole	142.92 **	85.00	4.90 ***	33.11	48.7	4.8	14.02 5.80	0.02 0.50 Pillar	17.47

**Chamarajanagar includes the three divisions of BRT, Cauvery and MM Hills*
*** Data includes restoration of hold EPT*
**** Data includes rubble stone wall, stone wall, masonry wall and platform.*

Although a sampling of each type of barricades is stipulated as per ToR at 10% of the total barricades, sampling done in these areas are much higher than this giving a more reliable data for analysis. It is seen from the table that EPT, Solar and combination of EPT and Solar and rubble stone, Rail fence have been the main barriers in all the divisions. Rubble stones are mainly for short length to cover the gaps created in EPT's

or to reinforce the effectiveness of these barriers. RCC pillars and posts are also as a measure to overcome site specific problems.

In Ramanagara district, out of 1.86 km of EPT taken up during the study period, about 1.8 km has been sampled which is to an extent of 96 %. Similarly, solar fencing is taken up to the tune of 8.0 km and about 3.0 km has been sampled (37.5 % sampling). In Mysuru division, out of 9.3 km of EPT, 3.0 km has been sampled (32.3% sampling). Solar fencing sampling has been done to the extent of 29.2 %. Similarly, in Chamarajanagar, the sampling of EPT is to the tune of 42.1 %, and solar fence sampling is around 41%. In Madikeri EPT sampling is around 21.3 % while in Virajpete it is around 54 %. In Bandipur, EPT sampling is to the tune of 13 % and solar is around 30%. In case of Nagarahole, EPT sampling is done to an extent of 34.3%, solar and combination to an extent of 29.2%. While rubble stone wall sampling was about 10.6 % and railway barricades is to an extent of 52.8%. Thus, it can be seen that in most of the cases the sampling of barricades has been more than 10 % which is the required percentage as per ToR. Mandya division (District) did not have any barricades constructed during the study period hence no sampling was done. It is reported some EPT was taken up during the years 2010-11 and 2011-12. The quantum of sampling done is expected to give data on status of the barricades, its effectiveness in reducing the conflict and its deterrence abilities and its functional abilities. Inspection of different types of barricades have been carried out by using a checklist as enclosed at **Annexe-1.**

Sampling of these barricades reveals the status of these whether they are in functional condition without damage and serving the purpose and effective in its deterrence abilities. Taking few criteria such as the extent of damages, maintained or not, its functional abilities, whether they need some maintenance, whether they can be revived with maintenance, or cannot be put back to use, the barricades in general have been categorized as Good, Moderate and poor. Good has been categorized as damages less than 10 % and more or less maintained after construction and is serving the purpose with good deterrence abilities. Moderate is the status where damages to an extent of

not more than 25 % and needs maintenance and can be improved with its maintenance, and has satisfactory deterrence abilities. Some of those barricades which have damages to an extent of more than 50 % and difficult to bring back to use and some of them are abandoned are categorized as poor. The following table (Table 4) gives an idea about the status of barricades sampled and the qualities of the barricades.

Table 4 Physical condition of the barricades (as of 2020 & 2021) in percentage

District/Division	EPT			Solar			Combination			Rail fence			Rubble stone		
	Good	Mod	Poor	Good	Mod	Poor	Good	Mod	Poor	Good	Mod	Poor	Good	Mod	Poor
Ramanagara	-	-	100	-	67	33	-	-	-	-	-	-	-	-	-
Mysuru	-	75	25	-	75	25	-	50	50	-	-	-	-	-	-
Hunusur	-	-	-	-	-	-	-	-	-	-	-	-	100	-	-
Chamarajanagar	-	10	90	33	33	33	-	-	-	-	-	-	100	-	-
Mandya	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Madikeri (T)	-	13	87	-	-	-	-	-	-	-	-	-	-	-	-
Madikeri(WL)	50	50	-	-	-	-	-	33	67	-	-	-	-	-	-
Virajpete	-	100	-	100	-	-	-	-	-	-	-	-	-	-	-
Bandipur	85	15	-	100	-	-	100	-	-	100	-	-	100	-	-
Nagarahole	37	63	-	80	20	-	70	20	10	100	-	-	100	-	-

Good refers to: Barricades well maintained, functional and damage is less than 10 %
Moderate refers to: Barricades somewhat maintained, satisfactory functioning, damage less than 25%
Poor refers to: Barricades not maintained, non-functional, some are abandoned, damage more than 50 %
**Chamarajanagar includes the three divisions of BRT, Cauvery and MM Hills*

4.4.2. Status of barricades inspected

4.4.2.1 Elephant Proof Trenches

The evaluation period refers to the barricades constructed between 2014-15 to 2018-19. They were evaluated for their physical status in the years 2020 & 2021. From Table-4, it is seen that at the time of evaluation (sample checking) most of the EPT in Ramanagara district was categorized as poor as they are not maintained and more than 50 % are damaged and not functional and even with maintenance difficult to bring it back to functional status. It can be seen from the table that most of the barriers (EPT and Solar) taken up during 2014-15 have not been doing well. Ranging from poor status of 67 % in Ramanagara to 100 % in Madikeri to 40 % in Chamarajanagar. Some of them have been moderate which requires maintenance.

With the exception of those constructed during 2014-15 have been in good status probably due to proper maintenance. Those taken up during 2015-16, some of them have been moderate being functional but needs maintenance as seen in Chamarajanagar, Bandipur and Nagarahole. There appears to be no funds allocated for maintenance of these EPT's. constructed in 2014-15. In Mysuru, about 75 % of the EPT's are in moderate condition and 25 % is in poor condition. The one in moderate condition needs some maintenance and will have good functional abilities. These were taken up during the year 2017-18 & 2018-19. No maintenance funds were allocated for this. The EPT's which are categorized as poor, some of them can be made functional with proper maintenance and improvement on a case-by-case basis. However, it was poor in Madikeri mainly due to lack of maintenance. Madikeri (both territorial and Wildlife) and Nagarahole have barricades in moderate and poor status which were constructed during 2016-17. Bandipur and Nagarahole has some of them in good status mainly due to maintenance. With the exception of Madikeri (T) which has again poor status of EPT, rest of the barricades constructed during 2017-18 have been either good or moderate and functional indicating that those of recent construction (2017-18) were better maintained probably due to funds available for maintenance. The trend continues of the status of barricades constructed during 2018-19. Most of them are either good or moderate requiring some maintenance. But in case of Madikeri (T) the EPT constructed is poor probably because of heavy rainfall conditions and also lack of maintenance

In Chamarajanagar, most of the EPT which were taken up during the years 2014-15 & 2016-17 are in poor condition and not maintained, only about 10 % of them are in moderate condition which can be revived with some improvement and maintenance. In Hunusur division it is mostly special structures constructed during the study period in the form of RCC pillars, and all of them are in are in good working condition. In Madikeri (territorial) the EPT's constructed during the study period, some of them are maintained and some have been covered with bushes and silt accumulated and not maintained. About 13 % are in moderate condition which can be made functional with maintenance and about 87 % are in poor condition and not

maintained. However, EPT's in Madikeri (WL) division, about 50 % are in good condition and functioning and remaining 50 % are in moderate making the status of these EPT's as functional. Overall, in Madikeri the EPT's are functional but needs regular maintenance. However, combination of Solar and EPT in some places have not been maintained and are not properly functional (67%). In Virajpete both EPT and Solar status is functional and well maintained, with 100 % of EPT in moderate condition needing some maintenance and Solar 100 % in good condition. Probable reason that it is constructed during 2017-18 and is being maintained. Some of the old EPT's and Solar fence done earlier is not maintained and many are not functional. In Bandipur and Nagarahole, EPT's are in functional status with most of it falling in good and moderate category, but still, some of them needs regular maintenance. EPT's overall needs maintenance on regular basis as bushes and weeds and accumulation of soil will render it ineffective. In addition, some of the animals like wild boar, and smaller mammals will make way in the EPT for elephants to cross over. There is a need to monitor these on a regular basis and take timely action. In case of solar fencing also there is a need for regular maintenance as weeds growing will come in the way of its effectiveness.

The problem with the EPT is other wild animals such as wild boars and deer are the first to show the way to the elephants by making the trench easier to cross. In addition, collection of silt, weeds and rubbles will not only enable the elephants to cross but also reduce the life span and effectiveness of the EPT. The EPT's which are not maintained due to non-receipt or no provision of funds, are invariably abandoned after few years as there will be accumulation of silt, rubbles and weeds growing. One way of ensuring the maintenance of these EPT is to involve local communities through Panchayat. Picture of a non-maintained EPT which is almost abandoned is shown below:

EPTs which were constructed earlier during 2014-15 & 2016-17 were of a particular size which was revised later. The revised sizes were more effective in deterring the elephants from crossing over, provided if these are maintained otherwise the

effectiveness will be reduced. There has been two different size dimensions for EPT and subsequently, the standard size has been followed. EPT s are known to last longer depending on site conditions and maintenance. In drier localities and in flat terrains it is maintained well and the life span is also more. Regular maintenance work has to be taken up for EPT as they bound to get filled with soil and rubble. For an effective functioning EPT it has to be constructed in flat areas with continuous forest boundary as any gaps will make the exercise ineffective. In areas like Ramanagara district, where boundaries are diffused and fragmented forests, EPT may not be an appropriate choice. The EPT constructed in recent years (2017-18 & 2018-19) were in a better shape and maintained to some extent and are functional. In areas where the EPT's are in good condition (Mysuru Division) they are mostly recently constructed and are well maintained. EPT constructed during 2014-15 in Bandipur and 2016-17 at Nagarahole have been maintained well. Probable reason could be adequate fund availability for maintenance.

Adhering to proper dimensions in constructing the trenches is important. Discontinuing the trenches for various reasons such as roads will render it ineffective. In several studies, numerous failure points ranging from 0-21 per km length of trenches have been observed (Jayant *et al* 2007). Failure points were mainly due to roads maintained by the forest department or foot paths made by local people. In another study, (A Rocha India, 2006) it was found that a 10 km length of trench in Banneraghatta National Park had 882 failure points. The failure points and reasons thereof need to be looked into in detail and overcome them in new ones are constructed.

It can be concluded that most of the EPT and some of the solar constructed during earlier years of 2014-15, 2015-16 and to some extent in 2016-17 were in poor status mainly due to lack of maintenance and non-availability of funds and proper monitoring. However, those which have been constructed in the later years (2017-18 & 2018-19) are in better condition and functioning well and maintained well. In Bandipur and Nagarahole, most of the barricades constructed during the study period

have been well maintained and are in good or moderate status requiring some maintenance.

EPT's are still effective in site specific conditions such as plain and flat terrains and low rainfall areas and have good deterrence abilities. But, in most of the cases they are not maintained and hence not fully functional. The overall working of these EPTs constructed in the study area is not satisfactory as most of them lack maintenance. This aspect needs to be looked into before new EPT's are taken up.

4.4.2.2. Solar Fence

The next major barrier adopted in the area is solar fencing. Most of the Solar fence constructed in the study area has been functional with good deterring abilities. Except in few cases, where the solar fencing is taken up in the earlier years and not maintained have been made dysfunctional (Ramanagara). In case of Mysuru division, solar fencing taken up during 2017-18 is working satisfactorily and fully functional. In Chamarajanagar the condition of the solar fencing is relatively better with maintenance and most of them are functional. The status of sampled solar fences falls under good, moderate and poor in Chamarajanagar. Solar fence in Bandipur, Nagarahole and Virajpete is maintained well and functional and most of the status coming under good and moderate indicating they are maintained and only those under moderate needs some maintenance. Solar fencing both ground and tentacle type are in a better condition and are functional and relatively well maintained in all the areas and are working satisfactorily. Solar fencing is one of the most effective barriers with good deterring abilities both ground and tentacle type. In almost all the areas, solar fencing has been functioning well and working satisfactorily Pictures of solar fencing both types and its condition are shown below.

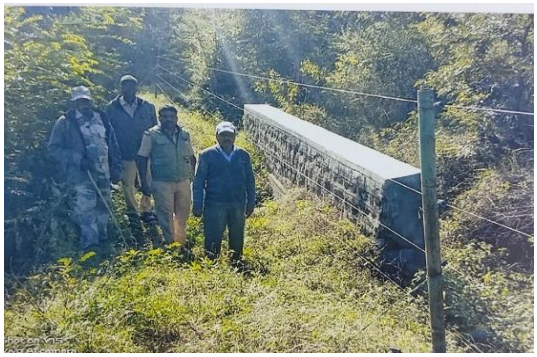
The regular ground solar fencing if not maintained, weeds start growing and touch the bottom wire, the elephants are known to push a pole and cross over thus making it ineffective. The maintenance involves the replacement of batteries and ensure sufficient power is there to infuse a mild shock to deter the elephants. Limitation exists

in the form of the fence itself and also due to not maintaining the fences. The solar fences mostly act as a psychological barrier for the elephants rather than physical. It is only a matter of time the elephants learn to overcome these fences. Studies have observed that guarding coupled with solar fence would be more deterrent (Desai *et al*, 2015).

In case of Mysuru division, solar fencing taken up during 2017-18 is working satisfactorily and fully functional. In Chamarajanagar the condition of the solar fence is relatively better with maintenance and most of them are functional. However, it is felt that these structures also need regular maintenance. For the solar fences constructed on the ground, it is essential to keep about 2 feet free from weeds and this has to be done on a regular basis. Solar fencing both ground and tentacle type are in a better condition and are functional and relatively well maintained in almost all the areas and are working satisfactorily. But it is observed that wherever they lack maintenance, functioning of solar fence is not satisfactory. These barricades need regular maintenance to make it more deterrent and work satisfactorily for longer periods. By not maintaining the very purpose of setting up these barricades is defeated and its life span goes down. Solar fence in Bandipur, Nagarahole and Virajpete is maintained well and functional. Only in parts of Madikeri the combination of Solar and EPT constructed during 2016-17 is non-functional due to lack of maintenance. Most of the farmers agree that solar fence is a god deterrent but during monsoon season they feel there is not enough power to deter the elephants. It is more suited in low or no canopy areas Pictures of solar fencing both types and its condition are shown below:

Solar fencing with EPT in Savanadurga

Community Solar Fencing by Farmers



Combination of Solar fencing with RCC in K Gudi

Combination of Solar fencing with EPT in Bylore

A tentacle solar fencing on the boundary of forest

Community solar fencing by farmers

4.4.2.3 Combination of Barricades

It is observed that no single barrier will reduce the conflict. Considering that EPT or solar fencing cannot be standalone in reducing the conflict, combination of solar and EPT has given good results and are found to more effective compared to either of the other two independently. Studies have shown that a trench built alongside an electric fence in 1997-1998 was rated highly effective and eliminated human-elephant conflict (Jayant *et. al* 2007). However, maintenance of these needs to be monitored. If one of them is not maintained the overall effectiveness will be reduced. Further, it may not be possible to have both EPT and Solar everywhere due to cost involved and site requirements and can be taken up only in identified high risk areas. In Mysuru, Bandipur and Nagarahole where combination of solar and EPT were taken up have given good results. Combination of EPT and solar is used in Mysuru division. They

are functioning well with 50 % of them in good condition. Combination of solar fence and EPT and SM wall in Bandipur and solar tentacle with Rail fence in Nagarahole is giving good deterrent and maintained well. Pictures of combination of EPT and solar fence are shown.

Their deterring abilities are observed to be better than single barricades either of EPT or solar. Only in parts of Madikeri the combination of Solar and EPT constructed during 2016-17 is non-functional due to lack of maintenance and also probably due to high canopy areas. Studies have shown that a trench built alongside an electric fence in 1997-1998 was rated highly effective and eliminated human-elephant conflict (Jayant *et. al* 2007). However, maintenance of these needs to be monitored. If one of them is not maintained the overall effectiveness will be reduced. Further, it may not be possible to have both EPT and Solar everywhere due to cost involved and site requirements and can be taken up only in identified high risk areas. This combination of EPT and Solar needs regular maintenance and some of them are not working satisfactorily mainly due to lack of maintenance. Both the EPT and the solar fencing has to be maintained, if any one of them is not maintained, the combined effectiveness will not be satisfactory and it will reduce the performance and life of the overall combination.

In an observation in Thailand (Owen David, 2021), elephants are known to push down "permanent" barriers, drag logs onto electric fences to cross without getting shocked, change their routes to avoid passing motion sensored alarms, and slowly fill deep trenches with dirt, then work together to cross, leaving no member of the herd behind. It is seen that barriers and obstacles may be effective initially, they do not address long term issues and also reason why the elephants are venturing into human-dominated landscapes in the first place. It is seen that the combination of solar and EPT and with other barricades such as rubble stones are more effective than single barricades.

4.4.2.4. Special structures, RCC Pillars and Rail Fence

The permanent and special structures like RCC pillars and posts are generally taken up to reinforce the main barricades. Also, in some site-specific areas. There is no problem

of maintenance and their status is good. Rail fence also as of now has good status and is functional as most of them are constructed in 2016-17 and 2018-19. They have good deterrence abilities. But it is also observed that in rail fence the nuts and bolts which have been used to join the rails and also cross rails often get rusted and the joint becomes weak. These gaps have been spotted by the elephants and there have been instances where they have broken these and tried to come out. Further, the gap between the rails (cross rails) is about 3 feet which often elephants have tried to cross and enter adjoining areas. Although reducing the gap by additional cross bar may solve this problem, the cost will be huge, as already about Rs.100 -125 lakh is the expenditure per Km of rail fence. These technical aspects such as height of the rail fence and the existing gaps need to be looked into. However, Rail fence is a good barricade which has reduced the conflict to a considerable extent. But cost and its limitation of usage in specific areas needs to be addressed. Farmers have also expressed that wherever the barricades have been set up it needs to be maintained otherwise it will be futile after a year or two. Though many of the farmers expressed rail fence as the best barricade, it is not possible to have rail fence in all the places. Some of the farmers expressed that given proper training and monetary incentive, the barricades can be maintained by the community. This is one option which needs to be considered. Another being, maintenance agreement as has been done in few places.

Considering that one of the effective short-term measures to mitigate the conflict is physical barriers in the form of different barricades, site specific barricades and its effectiveness should be looked into along with proper maintenance.

Steel Rope Fence: This is a new designed barricade under trial and Technical details are appended in the **Annexe-9.**

Cost details are requested from the division on receipt of the same will be appended which may vary subject to site conditions

On discussion with PCCF (WL), trials are on regarding the Tamil Nadu model of Steel rope fence in Nagarahole NP. In addition, KFD is trying improvised barricades in Madikeri. There appears to be some technical as well as raw material shortcomings in the existing model, hence needs improvement on those grounds. Instead of concrete pillars which weigh 2.5 tonnes each and in those if the holes are not done properly, then elephants may exploit the weak sections of the pillar and rope. Suggestions such as fusion of two rail lines vertical placement for better performance. The entire exercise in a trial stage and its effect on large scale adoption for its effectiveness needs to be studied and which is under process by KFD. At present the cost is around 55-60 Lakhs per km. Department will take up further with TN FD if need arises

For further details the matter may be taken up at Government level with TN Forest Department

4.4.3 Suggestions for improved effectiveness

One way of ensuring maintenance of these barricades is to have in built system at the time of construction. The other option is to involve the local community in maintenance on an incentive-based mode. Apart from Forest Department, local communities are also the stake holders and their initiation and involvement will go a long way in reducing the mitigation through these barricades. Several models are being tried in this partnership with local communities, in Karnataka, the farmers are given 50 % subsidy to construct solar fencing around their farms and maintain them. With the condition that these farms are located within 5 km from forest boundary and also farmers cannot claim ex gratia for crop and property damages for ten years.

One another option which can be thought of is to motivate farmers to take up more of 'Community fencing' where instead of individual farms barricading with solar fence, a

collective effort to barricade few farms together may be looked into. To further encourage the farmers the extent of subsidy may be raised to another ten percent if 'Community fencing 'is taken up. This will help in collective maintenance and more responsibility towards the barricades. The other model in Odisha is that the farmers will chip with 10 % of the cost and Department will share 90 % and this includes five-year maintenance by the construction agency empaneled. This will ensure involvement of the stake holders (Department & villagers) and reduces the HEC. Going one step ahead in case of orchards and commercial crop growers the share could be 50 -50 on the same lines of partnership.

Another option to ensure maintenance of these barricades is to entrust the empaneled agency to maintain fo*r* at least initial 3 years for EPT and solar fencing. The cost of maintenance has to be in built in the construction cost, so that the problems of non-receipt of funds for maintenance can be overcome. In case of EPT, the department has to involve the local community to maintain on an incentive basis as this mandatorily needs maintenance.

To summarize the above observations, following are the reasons for poor status and non-functional of some of the barricades:

1. Selection of site for EPT (Avoid slope areas)
2. Lack of maintenance
3. Inadequate funds for maintenance or no provision for maintenance
4. In heavy rainfall areas like Madikeri EPT maintenance is difficult

Well maintained EPT

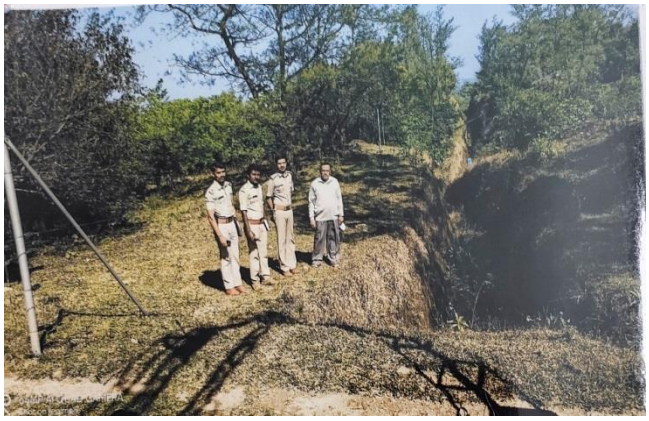
Rubble Stone Wall

Rubble stone wall reinforcing damaged EPT

Railway line barricade at Nagarahole boundary

Reasons for ineffectiveness of barricades

1. Discontinuous barricades covering the extent of boundary
2. Presence of gaps in the boundary interface
3. Identifying high severity areas of conflict



EPT at Talacuavery Range

EPT in Madikeri WL division

Rail fence with steel wire in Nagarahole NP

Following options are suggested for consideration for maintenance of the barricades in the long run:

1. Community involvement, training and monetary incentives for maintaining the barricades
2. Provision of funds for maintenance along with the construction of EPT and Solar fence
3. Maintenance of barricades agreement with the construction agencies.
4. Exploring the possibility of 'Community fencing' by solar fence and revising the subsidy rates in such cases to motivate and encourage the farmers

Summarizing the results from the data available on barricades and its effectiveness, it can be inferred that combination of Solar and EPT has given good results indicating that combined barricades fare better. However, in many places, EPT alone and Solar fence has been functioning well provided that they have been maintained. Rail fence has given good deterrent and reduce the conflict but it has limitations as far as usage in all conditions and the cost involved. Community fencing with solar fencing by farmers can be an area to be explored for better and effective results

Rail fence at MM Hills Range

Rubble stone wall at Cowdalli range

Tentacle Solar fencing at Hunusur WL Range

4.5 Data on Conflict and ex gratia

Primary data on damages due to HEC was collected as per the schedules by visiting the affected farmers and analyzing the same. Data on various aspects such as location of the village from forest boundary, time of raids, approximate area damaged, damage to property, injuries to human beings, death if any. Further, seasonality of crop raids, nature of crop damaged, extent of damage and stage of the crop. On the compensation side, information on the ex-gratia paid, whether it has been received in time or not, if not what is the time lapse, whether payment is made in one go or in instalments, whether ex gratia paid is adequate or not.

The above data is collected from the list of 128 affected villages covering the five districts. In each of the village, a maximum of ten affected farmers were visited to collect the details. However, there are instances where data for more than ten affected farmers were collected from sone villages. There are some villages where there may be one or two crop raids and none also. Following table shows the details

Table- 5: Table showing the selected villages and number of farmers visited Division wise

District	Forest Division	Number of selected villages	Number of affected farmers visited
Ramanagara	Ramanagara	26	191
Mysuru	Mysuru	14	47
	Hunusuru	5	9

Chamarajanagar	BRT	6	25
	MM Hills	10	55
	Cauvery	6	75
Mandya	Mandya	6	19
Kodagu	Madikeri (T)	12	93
	Madikeri (WL)	5	48
	Virajpete	4	35
	Bandipur	17	107
	Nagarahole	17	150
	Total	**128**	**854**

The above table shows that in 128 villages sampled, about 854 affected farmers have been visited and primary data collected from them as per schedule. The data has been analyzed and presented below:

The villages are selected based on the conflict existing with minimum of one crop raids. The following table shows the average raids per village based on the data collected. In most of the cases it is the crops which are raided and incidental damages occurs for property also and these have been taken into account as overall conflict and the damages are of different kinds.

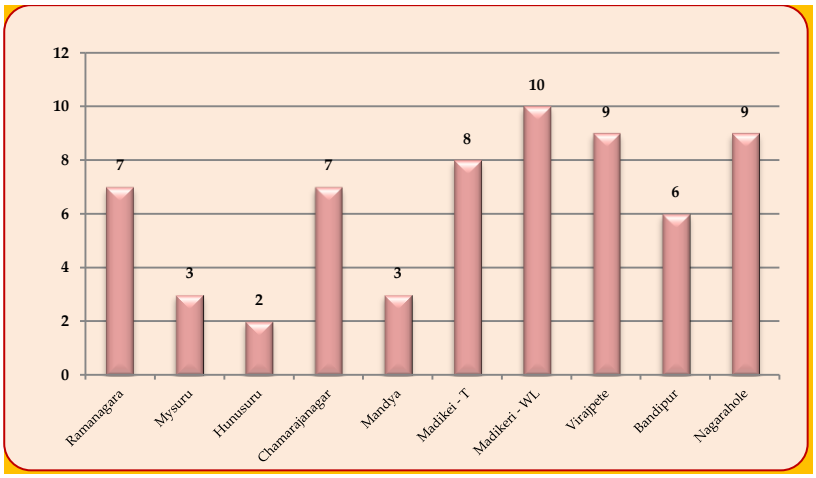
4.5.1 Crop raid cases in sampled villages

Table-6: Number of crop raid cases in sampled villages (Based on ex gratia paid) in the study areas

District	Forest Division	Number of villages sampled	Number of crop raids	Avg. No. of crop raids / village
Ramanagara	Ramanagara	26	191	7
Mysuru	Mysuru	14	47	3
	Hunusuru	5	9	2
Chamarajanagar*	Chamarajanagar	22	155	7
Mandya	Mandya	6	19	3
Kodagu	Madikei - T	12	93	8
	Madikeri - WL	5	48	10
	Virajpete	4	35	9
	Bandipur	17	107	6
	Nagarahole	17	150	9
Total		**128**	**854**	**7**

**Chamarajanagar includes the three divisions of BRT, Cauvery and MM Hills*

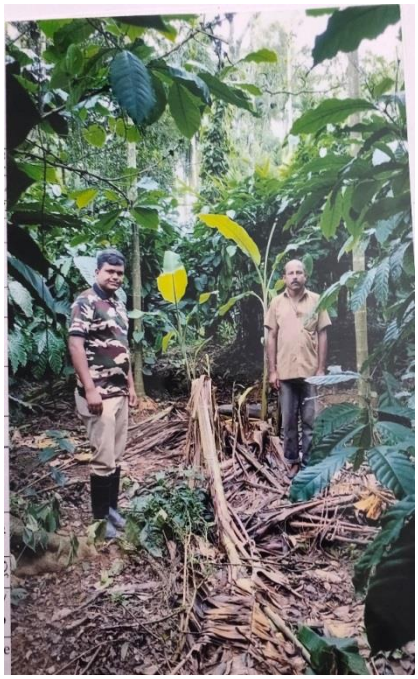
The average number of crop raids per village–division wise is graphically depicted below



The above table and the graph show the number of villages sampled in the study areas and the total number of crop raids in the sampled villages from where the data is collected. The number of cases of crop raids is based on the cases where crop compensation has been paid and recorded. In each village with a maximum of ten cases of crop raids have been recorded and data collected. The average number of cases per village varies from 2 to 10 from the data collected. This variation indicates that some of the villages have been affected more. In case of Ramanagara the average cases per village stands at 7, which is at par with Chamarajanagar. In Kodagu district all the three divisions where the affected village falls, have an average of 8-10 raids per village indicating high numbers. In Divisions like Mandya, Mysuru and Hunusuru the average is about 2-3 raids per village indicating low numbers. Bandiipur has an average of 6 raids per village compared to 9 at Nagarahole.

Kodagu, Ramanagara and Nagarahole Divisions have high number of raids per village compared to other areas. Within these divisions also number of raids vary with villages located in some of the ranges, some will have high numbers and some low. Villages located in some forest ranges such as:


Crop Damage cases at Madikeri and Makutta Range


Crop Damage cases at Makutta Range

Magadi, Channapatna and Sathanur in Ramangara district have more cases compared to other ranges. Similarly, villages in Nanjanagud and HD Kote Ranges have greater

number of cases. In Chamarajanagar, villages located in Hanur, Sangama and Mugur WL ranges have a greater number of cases. In Kodagu, villages coming under Madikeri, Samapje and Somwarpete and Srimangala ranges have high number of raids. In Bandipur, villages under Nugu, N. Begur, Moliyur and GS Betta have a greater number of raids. In Nagarahole, villages under Hunusur WL, Antarasanthe, Veeranahosahlli and D B Kuppe have high number of raids, showing the variation in number of raids in different ranges.

It is observed in districts such as Ramanagara where there has been administrative reshuffle after formation of Cauvery wildlife sanctuary the elephants have been frequenting the nearby villages from Cauvery Wildlife area. The incidents of crop raids have also increased after 2013-14. Monitoring the interface of the park and villages and efforts to prevent its entry into agriculture areas may be taken up on priority.

The probable reasons for some of the villages having a greater number of cases could be as observed in Ramanagara and Mysuru divisions due to the mosaic pattern of forest and villages interspersed and also availability of crops during the dry seasons. In Chamarajanagar, the fringed villages on the boundary appears to have more cases. To summarize the probable reasons for this variation are:

1. Fragmented forests interspersed with villages and habitation
2. Diffused boundaries in some cases
3. Proximity to the forest boundaries
4. Cropping pattern and seasonality
5. Nature of crops
6. Inadequate measures such as barricades

The pattern of variation of raids amongst the villages will give an idea as to managing the conflict by resorting to measures which can reduce the conflict. These measures could be setting up barricades in sensitive areas, possibility of change in the cropping pattern and better early warning communication network to avoid damages.

4.5.2 Proximity of village to forest

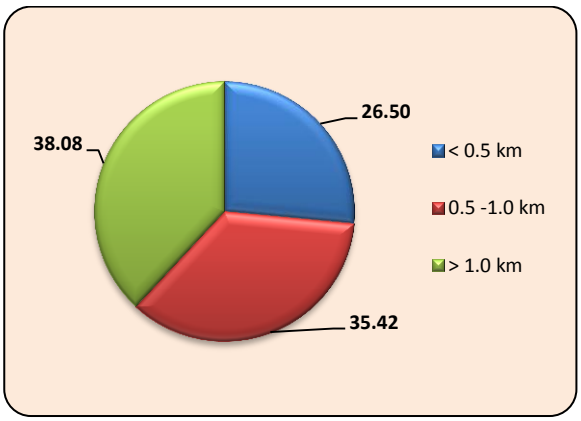
Location of the village and its proximity to the forest boundary is an important aspect to be considered while looking at crop and property damages in agriculture fields. Many villages are located adjoining the forest on the fringes and they are somewhat more vulnerable to raids by the elephants than those that are located little far away. But even those agriculture fields which are far away from the forests are also subjected to crop damages depending on the cropping pattern and seasonality. One of the important primary data collected from the affected farmers and their location and results are discussed below:

Table- 7: Percentage of crop Raids with reference to distance from Forest boundary

District	Forest Division	Percentage of raids		
		< 0.5 km	0.5 -1.0 km	> 1.0 km
Ramanagara	Ramanagara	19.2	53.3	27.5
Mysuru	Mysuru	22.0	22.0	56.0
	Hunusuru	33.3	66.7	-
Chamarajanagar*	Chamarajanagar	68.6	17.7	13.7
Mandya	Mandya	-	68.8	31.2
Kodagu	Madikeri – T	32.3	7.5	60.2
	Madikeri - WL	2.1	29.2	68.7
	Virajpete	20.0	17.1	62.9
	Bandipur	26.2	48.6	25.2
	Nagarahole	41.3	23.3	35.4
	Total	**26.50**	**35.42**	**38.08**

**Chamarajanagar includes the three divisions of BRT, Cauvery and MM Hills*

Percentage of raids- distance-wise across five districts



Villages which are located at a distance of less than 0.5 km from forests have varying percentage of raids ranging from 19.2 % in Ramanagara to 68.6 in Chamarajanagar, this compared to average for the category of 26.50 % of raids. Villages which are located between 0.5 to 1 km has raids ranging from 7.5 % in Madikeri territorial division to 68.8 in Mandya. This range is against the category average of 35.42 %. Villages located beyond I km from the forest boundary has percentage raids ranging from 13.7% in Chamarajanagar to 68.7% in Madikeri Wildlife Division against the average raids of 38.08 % in the category.

Chamarajanagar has crop raids of about 68.6 % in villages located within 0.5 km from forest boundary. Most of these villages are on the fringes and elephants tend to move outside into these areas for better forage and water. These villages are mainly growing non-commercial crops like Ragi, and paddy to an extent of 84 % and commercial crops like Banana and sugarcane to an extent of 15 %. Probably throughout the year some or the other crop will be grown in these villages with irrigation facilities.

Coffee Plants damaged at Makutta Range

As the distance increases from 0.5 and beyond the percentage of raids decrease with only 13.7 % raids in villages beyond one km. This indicates that villages which are nearer to compact and continuous forest areas are likely to be more vulnerable for raids. As elephants go in search of forage and water, they travel distances at times when availability of food and water is not adequate in nearby areas. In Chamarajanagar probably they may not travel much as the adjoining villages may

have sufficient forage and water when the elephants stary out of forests. Similar pattern is observed in villages located on the fringes of Nagarahole NP where in about 41.3 % of the raids have taken place in villages located within 0.5 km from forests.

Villages located between 0.5 km and 1.0 km from forest boundary in Ramangara, Mandya and Hunusur has more crop raids. This indicates that in areas which are mostly interspersed with forest, agriculture and human habitation, the percentage of raids goes beyond the nearness to the boundary. Fragmented patches of forests in areas of Ramanagara, Mysuru, Hunusuru and Mandya may not be adequate enough to provide forage and water for the elephants especially during the dry seasons and thus making them travel to distances in search of food and water. It is observed from Table 7 that, fragmented forest areas as seen in Ramanagara, Mysuru Hunusur and Mandya, the tendency of the elephants to come out of their natural habitats in search of forage and water is on the rise. This could be due to two reasons, increase in population of the elephants and the carrying capacity of the habitat. This is supported by the major portion of the percentage of raids in these divisions occur beyond 0.5 km from the forest boundary. However, even villages adjoining (between 0.5-1.0 km) Bandipur NP has raids to an extent of 48 % in this category indicating the elephant foraying into areas little far away in search of food and water.

In Kodagu district the villages located beyond 1.0 km from forests have consistently shown high crop raids in all the three divisions ranging from 60 - 68 %. Probable reasons could be the physiography of the area and location of the villages which may be spread out.

Some of the important observations from this data are, the elephants come out of their natural habitat mainly looking for forage and water. Fragmented patches of forests in areas of Ramanagara, Mysuru, Hunusur and Mandya may not be adequate enough to provide forage and water for the elephants especially during the dry seasons. Even in case of large tracts of forest of Chamarajanagar, Bandipur and Nagarahole the carrying capacity of the forests in terms of elephant population needs to be looked into. Apart from elephants foraging outside their territory, the migratory habit of the elephants is

also to be taken into account. Whether the elephant's migratory routes have undergone changes due to landscape changes resulting in increased conflicts is another issue. This is typically observed in Channapatna Taluk of Ramanagara District.

Though it is observed that elephants generally depredate on the fringes of the forest boundaries. It is reported that the crop lands at the edge of the reserves or PA's will be prone to increased intensity of crop damages. The analysis of this data of above table indicates that elephants forage beyond distances to crop fields located 3- 5 km from forest boundary if adequate food and water are not available in the forest and nearby areas. These incidents are on the rise and becoming common. There are instances where herds stray even for 25 km away from forest in Coimbatore. This may be one of such incidents but long-distance straying occurs in parts of Tamil Nadu and Karnataka. There are several studies on this behavior elephants related to crop raids and location of crop fields. Even agricultural lands at a distance of up to 5 km distance from PA's can experience severe crop losses (Thant *et al*, 2021). In a study (Naha et al, 2020) it is observed that Thirty-five percent of the villages were located within 500 m of a forest patch whereas overall 63% of the incidents occurred within 1.5 km. In another study in villages around Manas NP in Assam, villages adjacent to the park and crop raids were mostly concentrated along the park boundary. Similar observations have been made by others reporting high crop raiding incidents with proximity to the boundary (*et al* 2013). This observation will assist in identifying areas which are vulnerable for crop damages and conflicts and take precautions and preparing a vulnerability area map for the district to safeguard crops, property and human lives.

4.5.3 Time of raids

Another important component in HEC is the time of crop raids by the elephants. Elephants are known to forage through the afternoon into night. Generally, the peak time is in the evening and they take the darkness as the shelter during feeding. Most of the raid cases have taken place before mid-night and some after midnight. Elephants generally avoid human habitation during the day and resort to raids in the night.

Table - 8: Time of crop raids in the study area (in percentage)

District	Forest Division	Time of raids	
		Before mid-night	**After midnight**
Ramanagara	Ramanagara	79.2	20.8
Mysuru	Mysuru	86.0	14.0
	Hunusuru	100	-
Chamarajanagar*	Chamarajanagar	53.9	46.1
Mandya	Mandya	100	-
Kodagu	Madikeri – T	80.6	19.4
	Madikeri - WL	52.1	47.9
	Virajpete	100	-
	Bandipur	67.3	32.7
	Nagarahole	100	-
	Total	**81.9**	**18.1**

**Chamarajanagar includes the three divisions of BRT, Cauvery and MM Hills*

It is observed from the table that, generally the crop raid occurs during the night times. However, to ascertain whether there is any specific time of raids or any pattern emerges so that adequate precautions can be taken to avoid the conflict, this point was discussed during field visits. It is seen from the table that about 81.9 % of the raids is happening before mid-night and about 18.1% occurs after mid night.

In almost all the divisions with the exception of Chamarajanagar, Bandipur, and parts of Madikeri the crop raids occur before mid-night. In these three areas some of the raids occur after mid night also and evenly distributed throughout the night. The cases of human deaths occur accidentally when encountering the elephant. One of the reasons for this is that, the farmers visiting their agricultural field during night for guarding or early morning to irrigate the crops as at that time power availability for operating the pump sets is ideal.

Several studies have shown that in North Bengal the raids have been nocturnal between 22.00 to 06.00 hrs. (Naha *et a*l 2020). It is also observed that fatal attacks on humans have taken place during night times. Most of the farmers in the elephant prone areas go to their farms for night guarding and the attacks happen at that time. One another problem observed in most of the rural areas is the power supply during day

times may not be adequate enough to run the motor pumps for irrigation. At night times when the situation improves, farmers go to their lands to operate the irrigation pumps and incidentally the elephant attacks happen resulting in human injury and death. Elephants are known to visit crop areas during night times and often stay till early morning hours.

Summarizing the information on the time of crop raids, as most of the raids happen during night times, taking precautions like night watching and communication network for early warning and forming squads or groups to drive the elephants and providing all necessary equipment to the groups is necessary. In addition, in areas where there is problem with power supply during day times, Department of power may be requested to provide power during day times for designated hours to such of those villages which are identified as more prone for raids so that farmers can operate the irrigation pumps during day time. In addition, providing street lights in the village through solar power will help the villagers to avoid the conflict and make them more secure.

4.5.4 Extent of Area damaged due to crop raids

When elephants raid cropped areas, the damage is extensive. They not only forage on crops but also damage is caused due to trampling and its movement. This data is collected mainly based on the ocular estimate of the affected farmer and also has a link with the quantum ex gratia paid. This data is correlated by the Department to assess the crop damages for ex gratia payment.

Table- 9: Area of damage (Extent) during raids (in Percent)

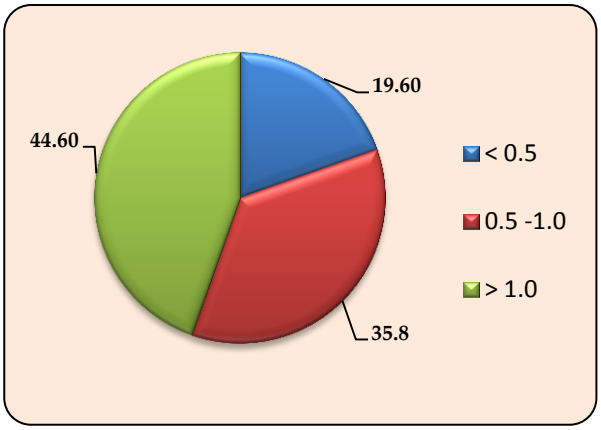
District	Forest Division	Area damaged (in acres)		
		< 0.5	0.5 -1.0	> 1.0
Ramanagara	Ramanagara	32.9	35.6	31.5
Mysuru	Mysuru	18.0	18.0	64.0
	Hunusuru	-	100	-
Chamarajanagar*	Chamarajanagar	16.7	27.0	56.3
Mandya	Mandya	25.0	50.0	25.0

Table-9: Area of damage (Extent) during raids (in Percent) ....

District	Forest Division	Area damaged (in acres)		
		< 0.5	0.5 -1.0	> 1.0
Kodagu	Madikeri - T	4.3	21.5	74.2
	Madikeri - WL	2.1	16.7	81.2
	Virajpete	14.3	31.4	54.3
	Bandipur	65.4	18.7	15.9
	Nagarahole	17.3	38.7	44.0
Total		**19.60**	**35.80**	**44.60**

**Chamarajanagar includes the three divisions of BRT, Cauvery and MM Hills*

Percentage of area damaged across five districts



It is observed from the table and the chart that the average area damaged during crop raids have been categorized into three. Overall average of all the divisions of the study area shows that most of them fall in 0.5 to 1.0 acre and above 1.0-acre slabs of the extent of area damaged. Districts of Ramangara, Mandya and Bandipur have more percentage of farmers coming under less than 0.5 acre of damage with Bandipur having highest of 65 %. Hunusur followed by Mandya, Ramangara, Nagarahole and Virajpete forms the major divisions where the affected farmers area is between 0.5 - 1.0 acre. The extent ranges from 31.4 % in Virajpete to 100 % in Hunusur. More than 1.0-acre extent of damage occurs high in Madikeri, Mysuru, Virajpete, Chamarajanagar and Nagarahole. The trend shows that there is high number of percentage of farmers coming under the category of 0.5 acre and above. If we take overall across all divisions, put together the last two categories amounts to 80.4 %

which is substantial. If the damage has occurred in marginal farmer's field, then not only it is economical loss but often a question of livelihood. Small and marginal farmers may be growing kharif crops which are rainfed and loss of that in a season amounts to loss for the entire year. The high percentage of farmers in the second and third category appears to bear significant damage and when it is considered for ex gratia payment it is not only the expenditure for the department but for the farmer undergoing it is not only economic loss but also the anxiety of the HEC.

The incessant crop raiding by the elephants has resulted in it affecting their food and livelihood security from the economic angle. Extensive food crop damage by elephants results in the yield getting diminished and also in case of non-commercial crops it adds to the loss in a long run. Eventually the reduced yields cause depleted food reserves and nutritional stress. There have been instances where some of the farmers have not been cultivating due to continuous crop raids by the elephants.

Considering that the ex-gratia payment for crop damages depend on the extent of damage and the crops destroyed, with the percentage of damages falling in the category of more than one acre, the financial involvement will be huge to the department looking at the regular damages.

When elephants raid the crops, the damage not only occurs due to feeding on the crops but also due to its movement and trampling in the area. The entire area is subjected to kind of depredation. The extent of such damages varies and often more in case of agricultural crops such as Ragi, Paddy and Maize. Picture showing the trampling of crops by elephants.

It is not only the actual damage occurring but also rendering the surrounding area unfit for any use. The large ranging pattern of the elephants makes the damages an intense one resulting in farmers not only put to economic loss but also under considerable mental agony and anxiety. HEC is known to affect the socio-economic security of the farmers resulting in challenges of the conservation aspect. It may result in eroding the local support as their life and property are at a high risk (Naba *et al* 2015). The extent of HEC is best measured in terms of economic loss as the conflict directly results in

economic loss to the communities living in proximity to elephant habitats. With agriculture being the backbone of the farmers economy, crop loss due to conflict has an adverse effect on the society as well (Naba *et al*, 2015).

The farmers who have lost the crop and some of them struggling for livelihood have to be compensated appropriately. The assessment of the damage occurring at present is done by the department officials, possibility of a committee consisting of agriculture and veterinary officials at local level might help the assessment nearer to realistic. However, the rates for ex gratia are fixed by the Government. To ease the difficulties the affected farmer has undergone, a quick and nearer realistic assessment and followed by ex gratia payment without any delay will go a long way in helping the farmers to overcome the problems.

Often elephants are known to prefer certain type of crops for feeding in the crop fields. During the course of which there may be damage more than normally what occurs. To examine the correlation if there is any between these two attributes, the Table-10 is presented.

Table-10: Table showing correlation between Area of damage and Type of crop

District	Forest Division	Area damaged (in acres)			Type of crop	
		< 0.5	0.5 -1.0	> 1.0	Commercial	Non-Commercial
Ramanagara	Ramanagara	32.9	35.6	31.5	52.1	47.9
Mysuru	Mysuru	18.0	18.0	64.0	54.0	46.0
	Hunusuru	-	100	-	-	100
Chamarajanagar*	Chamarajanagar	16.7	27.0	56.3	15.8	84.2
Mandya	Mandya	25.0	50.0	25.0	62.5	37.5
Kodagu	Madikeri - T	4.3	21.5	74.2	66.7	33.3
	Madikeri - WL	2.1	16.7	81.2	91.7	8.3
	Virajpete	14.3	31.4	54.3	68.6	31.4
	Bandipur	65.4	18.7	15.9	46.7	53.3
	Nagarahole	17.3	38.7	44.0	29.3	70.7
Total		**19.60**	**35.80**	**44.60**	**48.70**	**51.30**

**Chamarajanagar includes the three divisions of BRT, Cauvery and MM Hills*

It is observed from the table that overall across all divisions, the type of crop makes no difference for raided area as almost 46 % is in the category of area damaged being

more than one acre. Generally small and marginal farmers tend to go for field crops like Ragi, Maize, Jowar, pulses and paddy. Medium and large-scale farmers have larger holdings and go for commercial crops like Banana, mango, coconut and in Kodagu area mostly Coffee, pepper and cardamum along with paddy and banana. In Mysuru, Madikeri and virajpete wherever there is more percentage of commercial crops the corresponding percentage of area damaged happened to be highest in more than one acre. Indicating that there is some correlation between commercial crops and the extent of damage by elephant raids. In Case of farmers whose area is less than one acre (combined first and second category) around Bandipur about 84 % of the farmers come under this and it is correlated to about 53 % of the farmers growing non-commercial crop (presumably field crops). Similar trend is observed in farmers around Nagarahole NP with 56 % of the farmers whose area damaged is less than one acre and about 70 % of the farmers are growing field crops.

Thus, there are some indications that farmers probably with less holdings who go for more of field crops (non-commercial) their extent of damage is less than one acre and those with holdings and area damaged more than one care may have gone more for commercial crops depending on the area and locality.

4.5.5 Seasonality of raids

Elephants are known to move in search of food and water outside their territory. The general notion is that when the food and water are scarce during particular seasons they migrate to areas in search of these basic things. However, it is also observed that they have developed affinity towards agriculture crops and foray in search of field crops. Although they foray for most part of the time, there is a pattern in the crop raids that in some season it will be peak and at times it is low. The following table shows the seasonality of crop raids in different divisions.

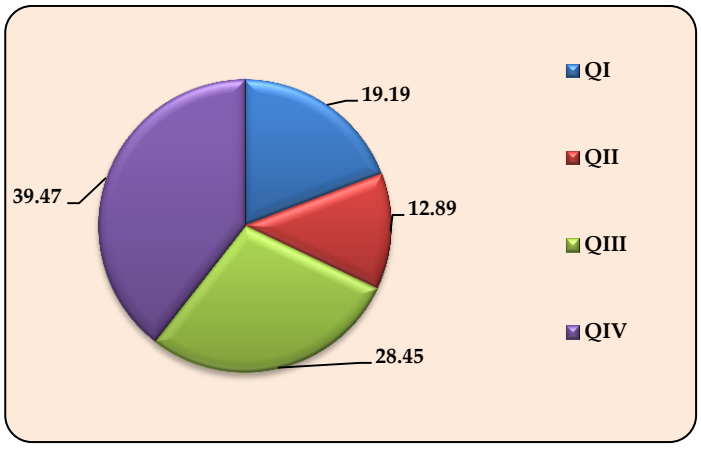
Table -11: Seasonality of raids in each quarter (percentage of raids).

District	Forest Division	Quarter			
		I	II	III	IV
Ramanagara	Ramanagara	40.3	32.6	12.6	14.5
Mysuru	Mysuru	22.0	0	24.0	54.0
	Hunusuru	-	-	100	-
Chamarajanagar*	Chamarajanagar	38.6	6.5	15.2	39.7
Mandya	Mandya	25	-	-	75
Kodagu	Madikeri – T	4.3	9.7	17.2	68.8
	Madikeri - WL	33.3	20.8	4.2	41.7
	Virajpete	2.9	37.1	17.1	42.9
	Bandipur	21.5	7.5	42.2	28.8
	Nagarahole	4	14.7	52	29.3
Total		**19.19**	**12.89**	**28.45**	**39.47**

Quarter I: Jan- Mar, Quarter II: Apr – Jun, Quarter III: Jul – Sep, Quarter IV: Oct – Dec

**Chamarajanagar includes the three divisions of BRT, Cauvery and MM Hills*

Percentage of raids season (quarter) wise across districts



It is observed from the table that overall percentage of raids is highest (39.47%) in the quarter of Oct- Dec, followed by 28.45 in quarter of July – Sep. Generally, these are the months coinciding with harvest of many crops. These are also months after the SW monsoon stops in September. Post monsoon, the conditions between October to

May it is relatively dry period except for returning monsoon in some areas. This is also the period when elephants go in search of food and water. The quarters III and IV put together have as many as 68 % of the raids compared to 19.19% in the first and 12.89% in the second quarters.

Almost all the divisions have a greater number of raids in the III and IV quarters ranging from 14.5 to 75 (IV quarter) and followed by III quarter which has raids from 4.2 to 100. Ramanagara has maximum raids in the I quarter which also happens to be drier months in the district. The trend continues in the second quarter also probably due to continuous cropping pattern due to irrigation facilities. This trend is also seen to some extent in Chamarajanagar and parts of Madikeri. Mysuru also has considerable raids in the drier months of the first quarter and continues in the third and fourth. Hunusur has all its raids in the third quarter. The entire Kodagu district has most of its raids in the IV quarter. Villages near Bandipur has most of its raids in III and IV quarter (71%). Nagarahole also shows the same trend with 81 % in these two quarters. Thus, it can be seen that the months from October to March (quarters III, IV & I) have maximum raids taking place. The second quarter almost coincides with the monsoon and probably the elephants have something to feed upon in their habitats and may not stray that much outside its territory.

To analyze further, the pattern of raids month wise was looked into and the following table gives month wise raids

Table 11 : Table showing seasonality of raids month wise during the study period (In percentage)

District/Division	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ramanagara	26	05	11	02	23	01	03	-	08	03	07	12
Mysuru	16	-	06	-	-	-	04	10	10	04	24	26
Hunusur	-	-	-	-	-	-	-	-	50	50	-	-
Chamarajanagar	28	-	13	02	-	01	01	02	12	02	21	18
Mandya	15	-	10	-	-	-	-	-	-	20	25	30
Madikeri (T)	04	-	-	-	10	-	-	08	09	18	25	26
Madikeri (WL)	15	08	10	12	08	-	-	-	04	15	08	20
Virajpete	03	-	-	13	24	-	-	07	10	12	18	13
Bandipur	11	10	-	8	-	-	11	13	18	8	12	10
Nagarahole	4	-	-	-	8	6	6	18	28	7	12	11
Total (Ave)	**12.2**	**2.3**	**5.0**	**3.7**	**7.3**	**0.8**	**2.5**	**5.8**	**14.9**	**13.9**	**14.2**	**17.4**

It may be seen from the above table that the months of October, November, December and January combined has crop raids to an extent of 57 %. Indicating that these are the months when crops attain maturity and period of post monsoon and relatively dry period. This may result in elephants' foray outside their territory for food and water. Almost all the divisions in the study area shows more percentage of crop raids from September to January. But in some divisions like Ramanagara, Madikeri (WL), Chamarajanagar and Nagarahole the riads continue during most months in the year with peaks reaching in the above-mentioned months.

The seasonality of crop raids by elephants have been studied extensively in India. Similar to their preference of raiding crops in the night, seasonal peak occurs in case of raids. Generally, the raids are peak during summer months and also post monsoon It is seen from the data that in all the three areas, fourth quarter (months of October – December) and first quarter (months of January to March) which coincides with post monsoon and drier summer months. There is some spill over in the second quarter also due to continued summer months of April and May. The low level of percentage of raids in the second quarter is mostly due to monsoon season when probably there is enough forage available in their natural habitat. Besides the season which is monsoon dependent, the maturity of crops also plays an important role in the raids. Seasonal raiding patterns have been associated with the harvesting of the specific crops, attraction to high nutrient quality and palatability, along with reduced chemical defenses and high-water retention of cultivated crops in comparison to wild vegetation, and also seasonal reduction in wild grass availability and quality in its natural habitat. In addition, the proximity of cultivation to the PA boundaries (Webber *et al*, 2011). Seasonality of crop raids is affected by the extent of availability of crops, proximity of elephants to the cultivation and possibilities of attractiveness of the crops in relation to wild forage.

Crop-raiding results in the destruction of agricultural cultivars through consumption, trampling, and uprooting, threatens farmers' economic and food security. Crop raiding

by elephants is a complex problem which varies from one area to another. With site specific characteristics, single mitigatory method may not work in all situations. It requires an understanding of the temporal patterns of crop feeding by elephants and the factors influencing them.

It can be summarized from the above data that in most of the cases in the five districts of elephant habitat, period from October to March is crucial with high number of raids. Post monsoon and drier months coincide with this period. Adequate measures need to be taken during this period as it also coincides with the harvest of the crops. It is also observed that there are crop raids occurs throughout the year possibly due to many areas being irrigated and the cropping pattern makes some or the other crop available throughout the year. This period is the vulnerable period and adequate precautions such as night watching, early warning system, network of communication, facilities to drive the elephants, besides the setting up of barricades is necessary. Although many of the farmers expressed that they are not willing to change the cropping pattern, some of them onioned that there is a need to not to go for crops like Banana which attract elephants.

4.5.6 Type of crop damaged

Elephants are known to have preference for some crops while raid takes place. Either due to inadequate forage and water in its habitat or due to availability of crops proximity to the forests have developed the habit of raiding crops and preference for some crops over a period of time. With many villages having facilities for irrigation, more and more commercial crops are being taken up by the farmers after substantial investment. Some of these crops also happen to be attractants for the elephants, especially crops like Banana, Coconut. And even among the food crops Paddy and Ragi are also known to be preferred by the elephants.

Table – 12: Type of crop damaged during raids (percentage of total raids)

District	Forest Division	Type of crop*	
		Commercial	Non-commercial
Ramanagara	Ramanagara	52.1	47.9
Mysuru	Mysuru	54.0	46.0
	Hunusuru	-	100
Chamarajanagar**	Chamarajanagar	15.8	84.2
Mandya	Mandya	62.5	37.5
Kodagu	Madikeri - T	66.7	33.3
	Madikeri - WL	91.7	8.3
	Virajpete	68.6	31.4
	Bandipur	46.7	53.3
	Nagarahole	29.3	70.7
Total		**48.7**	**51.3**

**Type of crop under commercial and non-commercial is listed in Annexure-8*
***Chamarajanagar includes the three divisions of BRT, Cauvery and MM Hills*

It is observed from the data collected and presented in the above table that about 48.70% of commercial crops and about 51.3 % of non-commercial crops were raided in the affected farmers' fields. This shows no significant differences in the overall picture where both commercial and regular field crops were damaged. But in the districts/divisions have their own cropping pattern with preference to commercial or to field crops. Kodagu, Mysuru Mandya and Ramanagara are known to have more of commercial crops than field crops. Whereas farmers around Chamarajanagar, Hunusur, Nagarahole, Bandipur, have more preference for field crops.

Among the commercial crops, farmers in Kodagu grow Coffee, cardamum, Arecanut, Pepper, Banana and paddy and these are the crops which are depredated. Villages around Bandipur are growing banana, sugarcane, paddy, and vegetables. Villagers around Mandya grow Paddy and sugarcane. Ramangara district has variety of crops being grown. About 52.1% has commercial crops in terms of Coconut, Mango and Banana. At the same time about 47.9% has area covered under food crops like Ragi, paddy, maize and pulses.

In Mysuru division the pattern more or less is similar to Ramanagara. About 54.0% of depredation is commercial crops comprising of Coconut, Mango and Banana and

about 46% is non-commercial food crops such as Ragi, Paddy, Maize and Red gram. In these areas crops are grown with tank irrigated and as a result, variety of crops are grown and this also attracts the elephants if the villages are located near the vicinity of the boundary of forests.

However, in Chamarajanagar, the scenario appears to be different with major portion of the depredation comprising of food crops such as Ragi and Paddy which is about 84.2 %. Commercial crops such as Coconut, Sugarcane is depredated to an extent of 15.2 % in the area.

The extent of damage for both commercial and non-commercial appears to be at par without any discrimination. There does not appear to be any preference to the crop damaged. It is observed that the preference of elephants for raiding the crops have been, Ragi, Paddy, Red gram and Maize among the food crops and Coconut, Banana, Mango, Coffee, Pepper, Arecanut, Jack fruit, Papaya among the commercial crops. Often vegetable crops like tomato and elephant grass have also been raided.

Studies have shown that the elephants have preference for the crops and stages of the crop as discussed in the above paragraphs. The crop raid data shows that in the above areas the crops damaged are without any preference. The reason could be most of the commercial crops are grown under irrigated conditions and are available during the peak season of raids and at the same time the crops may attain maturity attracting the elephants.

To summarize the type of crop damaged in the study areas, though there is no preference for nature of crops, probably it is the food crops and its maturity and the proximity to the forest boundary which attracts them for raids. As far as commercial crops are concerned crops such as sugarcane, banana coconut is depraded. These aspects have to be taken into account to devise a strategy for mitigating the conflict and reduce the crops being raided.

4.5.7. Stage of crop raided

Elephants are known to raid crops which are near harvesting or at harvesting stage this

is observed mainly in field crops whose maturity or harvesting period coincides with the drier seasons. Even in case of commercial crops though they prefer certain stage in which either they bear fruits or ready to eat stages are preferred. But it is also observed that in crops like coconut the young seedlings are damaged by taking away their growing part and sucking the juice and throwing it away and in such cases if the young coconut plant's growing part is damaged, the plant dies.

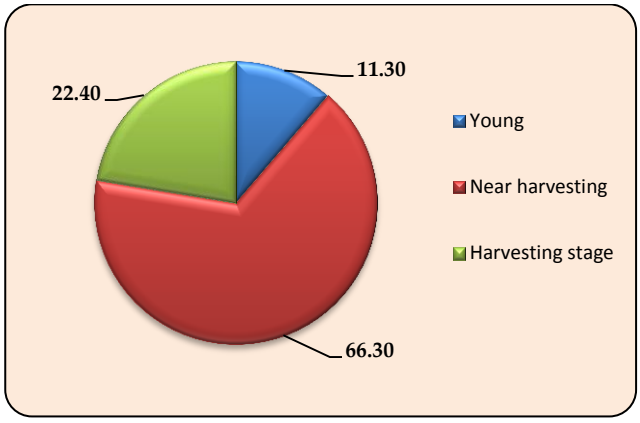
The following data shows the stage of crops damaged in the five districts:

Table-13: Table showing stage of the crop raided (percentage of total raids)

District	Forest Division	Stage of crop		
		Young	Near harvesting	Harvesting stage
Ramanagara	Ramanagara	2.6	46.8	50.6
Mysuru	Mysuru	2.0	74.0	24.0
	Hunusuru	100	-	-
Chamarajanagar*	Chamarajanagar	3.0	69.8	27.2
Mandya	Mandya	-	100	-
Kodagu	Madikeri – T	-	98.9	1.1
	Madikeri - WL	-	100	-
	Virajpete	-	-	100
	Bandipur	5.6	94.4	-
	Nagarahole	-	78.7	21.3
Total		**11.30**	**66.30**	**22.40**

**Chamarajanagar includes the three divisions of BRT, Cauvery and MM Hills*

Stage of crop across districts are presented in the pie diagram



It is observed from the data that the stage of the crop when it attains near harvest and

harvesting has maximum damage to the extent of 88.7% of the total raids. Some of the young crops are also damaged which could be incidental rather than getting attracted. There appears to be subtle difference between crops nearing harvesting stage and which are ready for harvesting. It appears that when a crop attains maturity and coinciding with the season when the elephants are in search of food, the maximum raids and damages occur.

In some districts like Ramanagara, and to some extent in Mysuru, Chamarajanagar, the raids have been distributed between near harvesting and harvesting stage though not significant. But in most of the other areas it coincides with the seasonality.

Most of the area the depredation occurs on crops which are near harvesting or reached harvesting indicating the stage of the crop preferences at the time of raids. In Ramanagara about 46.8 % is raided when the crops are near harvesting stage and about 50.6 % is on crops which are at harvesting stage. In case of Mysuru the major part of the crop raid is when the crops have reached near harvesting stage indicating the elephant preference and the vulnerable stage of the crops. Only about 24 % of the crops are raided when they are in harvesting stage. In Chamarajanagar district, most of the crop raids about 69.8% is at sage of the crop when they are near harvesting and about 27.2 % when they are harvesting stage.

This trend indicates that the stage of near harvesting and harvesting stage of the crops are vulnerable. However, there may be thin line between the stages of near harvesting and harvesting stages with many crops as mentioned above This probably applies more in case of non-commercial crops grown in these areas such as Paddy, Ragi, Maize, Red gram which are seasonal and comes to harvest mainly during post monsoon season.

From the above discussion, there is preference for raiding the crops at mature stage. In this regard, data collected from the study areas confirms the hypothesis. The categories made while collecting the data is young and near harvesting and harvesting stages, considering the near harvesting and harvesting stage cases shows that in Ramanagara almost 95 % of the raided cases fall in this crop stage. Similar trend is seen both

Mysuru and Chamarajanagar. In a study in Sri Lanka (Ekanayaka *et al* 2011) about 75% of raiding incidents were associated with mature crops. Damage to intermediate and early-stage crops corresponded to 15% and 10% of raiding incidents respectively. In another study (Ekanavyaka *et al* 2011) it is reported that three fourths of the crops raided by elephants in the study area were in the mature stage. Therefore, raiding of mature crops more than the other growth stages is preferred. This may be because the crop material that can be consumed per unit time feeding is higher when crops are mature. In addition, the nutritional value of crops increases when they mature. Most raiding incidents of perennial crops occurred in the mature stage of growth, possibly due to the greater abundance of mature stage plantations.

4.5.8 Stage of Crop raids and Seasonality

Elephant raids are generally associated with season and the stage of the crop. As discussed in the above paragraphs, the peak raids are in season and months which also coincides with crop maturity. Studies have shown that raids are common when the crops are matured and occurs during post monsoon period and this also happens to be drier season when elephants are foraying for food and water. The following table shows the linkages of season and stage of crop in the study area.

Table -14: Stage of crop raided and the seasonality of raids

Percentage of raids

District	Forest Division	Seasonality of Raids (%)					Stage of Crop (%)	
		I	II	III	IV	Young	Near Harvesting	Har-vesting
Ramanagara	Ramanagara	40.3	32.6	12.6	14.5	2.6	46.8	50.6
Mysuru	Mysuru	22.0	-	24.0	54.0	2.0	74.0	26.0
	Hunusuru	-	-	100	-	100	-	-
Chamaraja Nagar*	Chamaraja-naga	38.6	6.5	15.2	39.7	3.0	69.8	27.2
Mandya	Mandya	25.0	-	-	75.0	-	100	-
Kodagu	Madikeri – T	4.3	9.3	17.2	68.8	-	98.9	1.1
	Madikeri - WL	33.3	20.8	4.2	41.7	-	100	-
	Virajpete	2.9	37.1	17.1	42.9	-	-	100
	Bandipur	21.5	7.5	42.2	28.8	5.6	94.4	-
	Nagarahole	4.0	14.7	52.0	29.3	-	78.7	21.3
Total		**19.19**	**12.89**	**28.45**	**39.47**	**11.3**	**66.3**	**22.14**

**Chamarajanagar includes the three divisions of BRT, Cauvery and MM Hills*

It is observed from the above table that usually the crop raids take place at a stage

when the crops are near harvesting or at harvesting stage. This stage also coincides with the seasonality of the raids indicating the raids are maximum when the crop is ready for harvesting. It is seen that about 89 % of the raids occur when the crops are in maturity stage (Near harvesting & harvesting) and takes place in post monsoon and drier seasons when elephants are in search of food and water.

In Ramangara district, almost 68 % of the raids takes place in the months of January to June the first two quarters which is prior to monsoon and also relatively drier months. If the months of Oct- Dec (III Quarter) is also taken into account which are post monsoon months, about 88 % of the raids happens during these months, indicating that these are vulnerable months for raids. Most of the cereals and millets grown in these areas are seasonal and they come to maturity between September to December (III & IV quarters) depending on the duration of the crop and variety grown. Though in Ramanagara, the raids are less during these months of harvest, the drier months of Jan-March have maximum raids. With both commercial and non-commercial crops grown in equal percentage in the district, the trend indicates that both summer months and also the months of crop maturity (near harvesting & harvesting) stages are vulnerable for raids.

In Mysuru, the seasons of harvest of most of the seasonal food crops coincide with the maximum percentage of raids. With the months of July to December (III &IV quarters) having as much as 78 % of raids which coincide with 96 % of the crops being near harvesting or harvesting stage during this period. This indicates that the maximum raids are happening in the months of October to March (IV & I quarters). These months coincide with the summer and post monsoon also the harvesting stage of the seasonal crops.

The pattern continues in the district of Chamarajanagar where the months of October to March (IV & I quarters) have maximum raids with 78.3 % of them and coinciding with 87 % of the near and harvesting stage of the crop.

In Kodagu district also the pattern continues with maximum raids happening in III & IV quarters. Though the area is predominantly plantation crops being grown, paddy is

also widely grown. These months may not provide adequate forage and water to the elephants in their natural habitat and they foray into adjoining areas to raid on crops which are in maturity stage.

In areas adjoining Bandipur and Nagarahole NP, the trend continues with the III & IV quarters taking the maximum raids and crop stages at maturity.

In very few cases the young crops were damaged, and they may be more incidental rather than targeting as they do for the mature crops.

Overall observation for these areas indicates that about 58% of the raids happens in the months of October to March (I & IV quarters) and 88 % of the stage of the crop has reached either near harvesting or harvesting. The months between September to March is vulnerable period when adequate precautions need to be taken in areas of high HEC.

Correlating the data collected on seasonality of raids and the stage of crop shows that the peak raid percentage coincides with the near harvesting and harvesting stages of the crop (maturity). With the non-commercial food crops reaching harvesting stage in these quarters, the peak raids coincide with these seasons and the stages of the crop. In farms where they have commercial crops the raids on crops like banana occurs near mature stages. However, an interesting observation made during the field study is that the young coconut plants are damaged by removing the growing portion and sucking the sap by elephants. This is observed in Channapatna taluk.

Overall data shows that major portion of the raids takes place during the months of October to March, these months are the post monsoon months and also drier months. This period also coincides with the near harvesting and harvesting stage of the crop. The key indicators for mitigating the crop raids are the seasons and the stage of the crop when measures are to be initiated.

Thus, adequate measures can be taken up during these seasons and stage of the crop by engaging more man power and a coordinated network of early warning system and driving the elephants. All these have to be done with the involvement of local community and they have to be taken into confidence and a monetary incentive system

has to be devised. In addition, certain long-term measures such as carrying capacity and enrichment of habitat needs to be looked into.

4.5.9 Stage of Crop and type of crop

Following table makes an attempt to see whether there is any correlation between elephants raiding a particular stage of the crop and type of crop whether it is a field crop or a commercial crop as there may some preference for some crops.

Table- 15: Table showing the linkage between Stage of crop and type of crop

Percentage of raids

District	Forest Division	Stage of crop			Type of Crop	
		Young	Near harvesting	Harvesting stage	Commercial	Non commercial
Ramanagara	Ramanagara	2.6	46.8	50.6	52.1	47.9
Mysuru	Mysuru	2.0	74.0	24.0	54.0	46.0
	Hunusuru	100	-	-	-	100
Chamarajanagar*	Chamaraja-nagar	3.0	69.8	27.2	15.8	84.2
Mandya	Mandya	-	100	-	62.5	37.5

Table- 15: Table showing the linkage between Stage of crop and type of crop

Percentage of raids

District	Forest Division	Stage of crop			Type of Crop	
		Young	Near harvesting	Harvesting stage	Commercial	Non commercial
Kodagu	Madikeri–T	-	98.9	1.1	66.7	33.3
	Madikeri-WL	-	100	-	93.7	8.3
	Virajpete	-	-	100	68.6	31.4
	Bandipur	5.6	94.4	-	46.7	53.3
	Nagarahole	-	78.7	21.3	29.3	70.7
Total		**11.30**	**66.30**	**22.40**	**48.70**	**51.30**

**Chamarajanagar includes the three divisions of BRT, Cauvery and MM Hills*

Although no such correlation is observed between the two components here, as seen in Ramanagar, Mysuru and Mandya the raiding of the crops at maturity is immaterial of Filed crops and commercial crops. However, in Kodagu where it is predominantly plantation crops like Coffee, Cardamum and pepper along with paddy, the percentage of raids of commercial crop is higher than that of non- commercial crops. There could be a reason that the extent of non-commercial field crops in these areas could also be less. Hence no clear trend or correlation between these two can be inferred.

4.5.10 Extent of damage during raids

As mentioned earlier, when the elephants raid a cropped area, apart from feeding on the crops, often there is substantial damage to the crops and surrounding area rendering them unfit for any use. This extent of damage is at times incur more economic loss to the famer than the feeding on the actual crop. An assessment was made to look into this aspect to the extent of damage by scaling them less than 50 % of the area or more. Following table shows the extent of such damages data in the study area

Table- 16: Table showing Extent of damage to the crop* (In Percentage)

District	Forest Division	Extent of damage to the crop	
		Up to 50 percent*	More than 50 percent*
Ramanagara	Ramanagara	39.3	60.7
Mysuru	Mysuru	58.0	42.0
	Hunusuru	100	-
Chamarajanagar**	Chamarajanagar	71.8	28.2
Mandya	Mandya	12.5	87.5

Table- 16: Table showing Extent of damage to the crop* (In Percentage)….

District	Forest Division	Extent of damage to the crop	
		Up to 50 percent*	More than 50 percent*
Kodagu	Madikeri – T	60.2	39.8
	Madikeri - WL	85.4	14.6
	Virajpete	94.3	5.7
	Bandipur	80.4	19.6
	Nagarahole	85.3	14.7
Total		**68.70**	**31.30**

***Based on ocular estimate and as informed by the farmer. The damage occurred out of the total area raided*

***Chamarajanagar includes the three divisions of BRT, Cauvery and MM Hills*

The data from the table shows that overall, the damage occurs in the entire area raided is to an extent of less than 50 % is around 68 %. In some areas the damage exceeds the

total area more than 50% which is around 31 %. This it is seen that across all the divisions in the study area extent of damage is to an extent of 68 % in area where damage occurs to less than 50 % of the total area. This assessment is also basis for the ex-gratia payment as the area damaged has to be taken into account.

It is further observed that when a raid happens, apart from the depredation of the crop in the entire area the intensity of damage varies, sometimes less and at times the entire area. When a herd or single has moved in the fields, due to trampling and the movement there will damage to the crops which may be a young or mature or even trees or could be seasonal crops or commercial crops like Coconut, Mango and Banana. It was observed that in Ramanagara district, about 60 % of the farmers have indicated that the damaged area was more than 50 % and up to 90 % and about 40 % happens to be less than 50 % of the area. In Mysuru division, the extent of damage in the category of less than 50 % is around 58 % of the farmers fall in this category. Whereas 42 % falls under category of 50-90 % of the damages. In Chamarajanagar, the extent of farmers falling under damages less than 50 % is around 72 % indicating that the damages were probably more confined to depredation. In most of the areas adjoining divisions like Madikeri, Hunusuru, Bandipur, Nagarahole, the damages fall under the category of less than 50 % of the total area. The exception being Mandya which has 87 % of the damages in the second category.

Elephant raid involves not only feeding on the crops, it is the movement of the elephants which results in trampling, uprooting which also contributes to the economic loss as well as mental agony and anxiety for the farmer. For a farmer who has been growing commercial crops like banana, coconut, if the damage occurs to a well grown-up tree about to yield or yielding, the economic loss is maximum. Not only the crop yield is lost but the future crop is also lost as the tree is permanently damaged. Such cases have to be considered while ex gratia payment is made. While assessing the crop damage extent one has to consider these issues as the provision for ex gratia payment covers the entire extent of damage or only actuals need to be looked into. Formation of a committee with officials from department of agriculture and veterinary

go a long way in making a realistic assessment for ex gratia payment and also the famer will be satisfied.

4.5.11. Data on Ex-gratia

Elephant raids in the adjoining villages of the forest are more vulnerable and various damages ranging from crop, property, injury to animals, injury to human beings and death occurs. The affected person will tend to seek immediate compensation for his loss. Apart from the economic loss this is a sensitive issue as many times the livelihood is at stake and at times the bread winner for the family is killed and a bleak future looms large for the family. Generally, compensation is in the form of monetary payment for the damages after assessment by the department. Payment of ex gratia is a case where it is mostly addressing the effects rather than the cause. Many times, the affected person may not be satisfied with the compensation measures. In addition, associated problems of delayed payment and inadequate and not commensurate with the loss are the issues arising out. It is more of a support rather than compensating the loss which will involve economic as well as emotive. During the evaluation data collected on the various issues such as quantum of compensation paid for the damages, whether received in time or delayed and if so, what is the extent of delay and reasons for the same. Whether the payment is made in one go or in instalments is collected and analyzed and presented in the following paragraphs.

4.5.12. Quantum of ex gratia received

The data collected on the quantum of ex gratia paid is done through approved schedule and visiting the farmer and collecting the details together with department officials who had the records to verify. After perusing the data, different slabs of quantum of payment received were formed and the percentage of farmers in each category is recorded. The following table presents the data on quantum of payment made.

Table-17: Table showing percentage of farmers in different slabs of receipt of ex gratia payment

District	Forest Division	Ex gratia amount paid (Rs)		
		Less than 2000	2000- 3000	More than 3000
Ramanagara	Ramangara	27.2	17.3	55.5
Mysuru	Mysuru	40.0	20.0	40.0
	Hunusuru	-	-	100.0
Chamarajanagar*	Chamarajanagar	14.2	19.4	66.4
Mandya	Mandya	18.8	81.2	-
Kodagu	Madikeri -T	15.1	19.4	65.5
	Madikeri - WL	4.2	25.0	70.8
	Virajpete	-	37.1	62.9
	Bandipur	33.6	26.2	40.2
	Nagarahole	-	27.3	72.7
Total		**15.3**	**27.3**	**57.4**

**Chamarajanagar includes the three divisions of BRT, Cauvery and MM Hills*

It is observed from the table that the three categories or slabs of payment have been made and maximum percentage of 57. 4 % of compensation amount falls in category of more than Rs.3000. This also indicates the severity of conflict in all the areas. Compared to this slab, the lowest percentage of farmers at 15.3 % falls in the category of less than Rs.2000. About 27.3 % of the compensation paid falls in the category of Rs. 2000-3000.

In Ramanagara district, about 55.5 % of the farmers have received payment exceeding Rs.3000. indicating the intensity of damage to the crops. The trend continues in Mysuru Division with 40 % of the farmers receiving payment of more than Rs. 3000 and the same number have received less than Rs.2000. The extent of damage is severe in some places and comparatively mild in other places. However, in case of Chamarajanagar district 66 % of the farmers have received compensation of more than Rs.3000, indicating the damages are intensive. The entire Kodagu district has received maximum compensation in the category of above Rs.3000 indicating the extent of conflict and damages to crop and property. Farmers adjoining Nagarahole NP have

also received maximum in this category (72 % of the farmers). Hunusur has 100 % of the farmers visited falling under the category of receiving ex gratia of Rs. 3000 and above.

Information on the quantum of ex gratia paid to individual farmers depends on the intensity of damage and extent of the damage, nature of crop and stage of crop. The quantum of ex gratia paid is not uniform in the country and varies from state to state.

Farmers generally perceive that the damage and loss is actually much more than what assessment has been made to pay the ex-gratia amount. Their expectations are naturally high. However, the quantum of ex gratia paid in the study area is substantial and is shown in Table 17. It is indeed difficult to sustain that kind of ex gratia payment for long periods and the only recourse is to manage the conflict and crop damages by resorting to short- and long-term measures to a certain level.

The state has a novel method for compensating the human death due to elephant conflict. There is a proposal that to provide farmers 'grain for grain' in which the farmers are paid the quantum of food grains instead of monetary relief so that it provides food security A foundation has been formed in Kodagu as simple compensation payment does not solve the socio-economic disruption caused by the loss of an earning family member and that the children are the most adversely impacted. The objective of monitoring such families and providing sustained guidance and support till the children finish their education and the family is able to overcome the challenges posed by the loss.

There is also no mechanism to assess the actual crop loss and the monetary relief based on actual and its impact on the affected families on their economic status. The most affected farmers are the marginal farmers who practice subsistence agriculture and survival and livelihood depends on that are adversely affected. They are also the category of farmers who get the least ex gratia as they grow only food crops in small areas for their survival contrary to more ex-gratia received by farmers who grow commercial crops. It is indeed difficult to address the disparity, hence, it is essential that preventive measures and reducing the conflict and crop raids are priority.

However, in the present situation, the ex-gratia paid can be based on assessment by a committee rather than department alone so that it will be nearer to realistic damages and also satisfy the farmers. In addition, there should be a channel of a fast-track disbursement of the same without delay.

4.5.13. Elephant raid cases and ex gratia paid

The following table highlights the total number of cases due to elephant raids and the ex-gratia paid during the study period. The table also shows the trend of conflict increasing or decreasing based on the number of cases and the compensation paid. Based on the number of crop raid cases and ex gratia paid, severity of conflict has also been categorized

Table-18: Table showing number of conflict cases and ex gratia paid during the study period

Ex- gratia amount in Rs lakhs

District	Division	2014-15		2015-16		2016-17		2017-18		2018-19		Risk level
		No. of cases	Ex gratia	No. of cases	Ex gratia	No. of cases	Ex gratia	No. of cases	Ex gratia	No. of cases	Ex gratia	
Ramanagara	Ramanagara	2086	84.09	1947	74.84	1441	85.20	3095	179.9	2202	146.9	**High**
Mysuru	Mysuru	1248	28.69	767	20.20	1021	20.28	1478	43.31	1064	27.66	**Moderate**
	Hunasur	259	8.48	128	6.5	178	7.39	323	20.15	101	5.2	**Low**
Chamarajanagar*	Chamarajanagar	831	51.49	419	37.48	774	66.26	1569	96.16	1312	90.14	**Moderate**
Mandya	Mandya	59	7.82	33	7.78	34	2.80	23	3.92	16	3.17	**Low**
Kodagu	Madikeri T	1735	75.00	1228	68.9	1392	91.9	1513	89.8	1139	56.5	**High**
	Madikeri WL	1356	41.96	480	15.66	412	16.3	621	32.7	639	42.64	**Moderate**
	Virajpete	1087	74.73	1319	97.30	910	60.0	1739	125.0	1355	97.9	**High**
	Bandipur	NA	NA	3114	74.41	2737	90.9	1875	69.2	2723	103.4	**High**
	Nagarahole	1036	41.5	1030	48.24	951	59.09	742	57.12	756	44.98	**Moderate**

**Chamarajanagar includes the three divisions of BRT, Cauvery and MM Hills*

Data for the period of study on crop damage cases and compensation paid for different divisions are presented in the above table. The data shows that the number of cases and crop compensation paid over the five years in each study area more or less remains same with a low in 2016-17 and high in 2017-18. The cases in Ramanagara peaking during 2017-18, with 3095 cases and an amount of 179.9 lakhs was spent on ex gratia. The pattern remained the same in Mysuru with the number of cases. about 1478 incurring an amount of Rs.43.31 lakhs during the peak year of 2017-18. Hunusur appears to have relatively less raid cases compared to other divisions. Again, here also the peak was in 2017-18 with 323 cases and an amount of Rs.20.15 lakhs was paid as

ex gratia. In Chamarajanagar, cases increased during 2017-18 and 2018-19 and so also the ex-gratia paid during these years peaked, prior to that it was relatively low. Mandya also had fewer cases with a peak number of 59 during 2014-15 and an amount of Rs.7.82 lakhs was spent as ex gratia. Virajpete also had highest number of cases during the study period with 1759 and an amount of Rs.125 lakhs has been spent on payment of ex gratia. In Bandipur, the peak cases were in the year 2015-16 with 3114 and an amount of Rs.74.41 has been incurred. However, during 2018-19 though the number of cases stood at 2723, the amount spent was 103.4 lakhs. In Madikeri, the territorial division shows high number of cases throughout study period with peak number in 2014-15 at 1735. An amount of Rs.91.90 lakhs have been spent on ex-gratia payment during 2017-18. However, in case of Madikeri WL division, the cases are relatively glow with range of 412 to 629 cases annually. Probably due to the fact that, most of the area under wildlife has less interface with villages and may be scattered. In Nagarahole, the trend shows that, the number of cases during the study period showed some decline with the peak being in 2014-15 at 1036 cases. Subsequently, the reduced number shows some consistency with 742 and 756 in the last two years of the Study period.

The number of cases and amount spent on ex gratia is high in both Ramanagara, Mysuru and Virajpete. In the first two cases probable reason could be the fragmented patches of forests and interspersed with agriculture and habitation resulting inn frequent and more conflicts and cases. However, it is interesting to see that extent of barricades constructed during the study period also is comparatively less with 9.86 and 40.10 km. Even in contiguous forest tracts and hard boundaries like in Bandipur, the number of cases is high, the probable reason could be the elephant population and the carrying capacity and the type of habitat being predominantly dry deciduous with probable shortage of feed and water during drier seasons. The trend in number of cases and the amount spent on ex gratia over a period of five tears (from 2014-15 to 2018-19) remains more or less same.

Taking into consideration the number of cases and the amount of ex gratia paid, which

forms the basis for assessing the severity of HEC, divisions in the study area are classified as high, moderate and low risk areas. Villages around Ramanagara, Virajpete, Bandipur has been categorized as High-risk areas after taking into account both the number of cases and the compensation paid. In Mysuru division though the cases numbering high, the amount of compensation is relatively low. This has been categorized as moderate. Both Hunusur and Mandya with cases ranging from 181 and 33 and a compensation amount of Rs.9.54 lakhs and 5.10 lakhs annually on an average, these two-division have been categorized as low risk areas.

Each of the district has been categorized into three classes depending on the risk level which is based on the number of crop raid cases and ex gratia amount paid. Further based on the classification of landscape categories, the first category where the forests and agriculture and habitation are distributed in a mosaic pattern, divisions like Ramanagara, Hunusur, Mandya and Mysuru falls in this and the level of risk ranges from Low (Hunusur) to high (Ramanagara) and being moderate in Mysuru. In these areas it is EPT and solar fence barricades have been effective in deterring and reducing the conflict. The combination of these two have been more effective in reducing the conflict. But in large tracts of farm lands, solar fencing by farmers either with subsidy by the department or on their own appears to be popular in reducing the conflict. The solar fence and the combination of EPT and solar are cost effective measures in these areas.

In districts like Chamarajanagar, and divisions like Bandipur and Nagarahole where the boundaries are continuous and hard which falls in the second category of landscape classification, have risk categories between moderate and high. In these flat and plain areas, EPT is still popular and has good functional abilities. In additions solar fence has given good deterrent abilities. Combination of EPT and solar has been very effective in reducing the conflict. With rail fence being adopted as one of the barricades of late, it has been quite effective in managing the conflict. Though Rail fence is effective, it is the cost consideration which comes in the way of adopting on a large scale. However, in these areas solar fence and combination of solar and EPT have been cost effective and being adopted in large scale.

In hilly and undulating areas like Madikeri and Virajpete, which falls in the landscape category of hilly and undulating areas with forests and plantation crops such as coffee, the risk levels have been ranging from moderate to high. In these areas, solar fence has been effective compared to EPT and combination of Solar and EPT are good in these areas. These are the cost-effective barricades in these areas

Table -19: Table showing linkage between Barricades constructed and expenditure

(Length: in Kms, Amt.: Rs.in lakh)

District	Division	2014-15		2015-16		2016-17		2017-18		2018-19	
		length	amount	Length	Amount	Length	Amount	Length	Amount	Length	Amount
Ramangara	Ramanagara	6.86	12.74	-	-	3	6.63	-	-	-	-
Mysuru	Mysuru	-	-	-	-	-	-	18.3	76.68	20.8	97.97
Ch'nagar*	Ch'nagar	136.3	292.3	230.2	618.1	46.6	296.1	75.7	423.0	35.9	262.3
Mysuru	Hunusur	9.87	38.9	6.5	16.7	-	-	0.02	3.20	-	-
Mandya	Mandya	-	-	-	-	-	-	-	-	-	-
Kodagu	Madikeri T	15.5	76.2	18.7	64.2	41.6	209.7	19.7	310.6	3.0	389.3
	Madikeri - WL	14.3	56.9	5.0	37.9	-	-	-	-	6.15	5.81
	Virajpete	1.12	15.83	318**	31.49	8.02	46.5	-	-	-	-
	Bandipur	25.2	653.1	3.6	126.7	57.8	955.5	15.9	207.0	74.4	762.3
	Nagarahole	3.15	1190.9	10.44	1452.9	13.47	612.9	23.43	1110.4	41.0	790.2
Total		212.30	2336.87	592.44	2347.99	170.49	2127.33	153.05	2130.88	181.25	2307.88

**Chamarajanagar includes the three divisions of BRT, Cauvery and MM Hills*
***No. of posts.*

It is seen from the Table 19, the total length of barricades set up during the study period in the study areas show that in both Ramanagara and Mysuru, is comparatively less compared to other areas. In Mysuru during 2017-18 and 2018-19 only about 39.1 km of barriers are set up compared to 382 km of Chamarajanagar district. It is further seen that, in divisions like Hunusur and Virajpet, the extent of length of barricades is quite low with 16.3 and 9.14 km. during entire study period across all types of barricades. This indicates probable lesser extent of conflict has seen in Hunusur and also fragmented forests where it may not be tenable for barricading the areas. In case of Madikeri Territorial division and Bandipur and Nagarahole the extent of barricades is commensurate with the vast forest areas and boundaries. These extends of barricades have relatively reduced the conflict.

It can be inferred that in a compact and continuous forest boundary the barricades set up and maintained have reduced conflict. In the other two areas of Ramanagara and

Mysuru the nature of land scape and difficulty in setting up barricades have resulted in a greater number of cases and ex gratia payment. However, there is a need to look at other options as already discussed in the remaining areas and minimize the conflict.

Based on the study, the forest divisions have been categorised as low, moderate and high-risk areas based on number of crop depredation cases and the ex-gratia paid. The high-risk areas can be considered as hot spots. Based on this assessment following divisions in the study area falls under high-risk ones. Divisions like Ramanagara, Madikeri (Territorial), Virajpete and Bandipur falls under high-risk category. Here the measures comprise of Preventive and protective. As a preventive measure, early warning systems, community involvement, training the village groups and providing them facilities to drive the elephants. Protective measures being setting up of barricades which are found to be best for these divisions have been brought out under Chapter of Findings and discussions and Recommendations. The other measure is to granting of ex gratia payment to the affected persons and expediting this measure is discussed in detail.

The hot spots have been identified by the KFD using the data available and the same will utilised and necessary action be initiated. About 49 corridors have been identified. Superimposing this data regarding the corridors with crop depredation cases and other details, will give an idea to prioritise the acquisition of land parcels for restoration of the corridors. Once this is done then in the other areas measures such as barricades and other complimentary measures can be together will assist in managing the conflict. The approach has to be multi-pronged with habitat improvement, restoration of corridors wherever possible and also erecting the barricades and expedition ex gratia payments.

4.5.14 Number of conflict cases and barricades

One of the hypotheses is that presence of barricades in any division or district and its extent will reduce the conflict. One such indicator of reduction in conflict is the number of cases registered and ex gratia paid. The following table shows the extent of barricades in each division and the number of cases during the study period.

Table-20: Table showing the extent of barricades (in km) and Number of conflict cases during 2014-15 to 2018-19

District	Division	Extent of barricades in km	(In Km)				
			2014-15	2015-16	2016-17	2017-18	2018-19
Ramanagar	Ramanagar	9.86	2085	1947	1441	3095	2202
Mysuru	Mysuru	40.10	1248	767	1021	1478	1064
	Hunusuru	16.41	259	128	178	323	101
Chamaraja-nagar*	Chamaraja-nagar	386.23	831	419	774	1569	1312
Mandya	Mandya	Nil	59	33	34	23	16
Kodagu	Madikeri - T	110.45	1755	1228	1392	1513	1139
	Madikeri WL	59.04	1356	480	412	621	639
	Virajpete	9.14	1087	1319	910	1739	1355
	Bandipur	243.65	NA	3114	2737	1875	2723
	Nagarahole	265.9	1036	1030	951	742	756

**Chamarajanagar includes the three divisions of BRT, Cauvery and MM Hills*

From the above table it can be seen that in Ramanagara, the barricades set up during the study period is only about 9.86 km and the number of cases is ranging from 1441 in 2016-17 to 3095 in 2017-18. In case of Mysuru also with only 40.10 km the cases range from 767 to 1248. In Chamarajanagar, with 386 km of barricades across all types, the cases have been relatively low ranging from a low of 419 cases in 2015-16 to a high of 1569 in 2017-18. In case of Kodagu, Madikeri Territorial has a length of 110 kms of barricades around its forests and the cases range from a low of 1139 in 2018-19 to a peak of 1755 in 2014-15. Incase of the WL division the barricades were to an extent of 59 km and the cases range from 412 to 1356. But the trend has been declining in the cases.

Virajpete also has only 9.14 Km of barricades and the cases range from 910 to 1739. In Bandipur, with about 243.65 km of barricades, cases are also high, the reason could be the continuous forest tract and the extended boundary and location of villages adjoining these boundaries. Nagarahole with a length of 265 km, the trend is declining cases annually and a low of 712 is observed, in 2017-18. Some inference can be drawn from Ramanagara and Mysuru and Virajpete where the barricades

constructed during the period range from 9.14 to 40.10 km and the cases are high. One probable reason could be the fragmented patches of forest interspersed with agriculture and habitation and setting up barricades would be un tenable and the cases are naturally high.

Overall impact of various mitigation measures such as different types of barricades and other complimentary measures taken by the department and community is seen on two fronts. One being the reduction in number of crop raid cases and the other being the extent of ex gratia paid. From the Tables 18 and 19 it can be seen that in areas with continuous hard boundaries interfacing with villages, barricades extensively taken up have helped in managing the conflict. This trend can be seen in Chamarajanagar, Bandipur and Nagarahole. However, in areas where fragmented forests are interspersed with agriculture and habitation, the effect or impact of barricades have not been much. This is mainly due to the fact that erecting these barricades all over in fragmented patches of forest boundaries is untenable and will not be cost effective. In such cases, solar fence as a barricade around the agriculture farms are more effective in terms of cost and impact of physical barricades. In these areas there is always gaps for the elephants to foray into cropped areas in search of forage and water. In these areas, wherever there is hard boundary interfacing with villages as seen in Magadi Range of Ramanagara district, the impact of barricades (rail fence) has been effective in reducing the conflict.

However, there has been no clear trend about the impact of the barricades and complimentary measures on the number of cases and ex gratia paid which are the primary indicators. Though in some years the figures show reduction in cases and also the ex-gratia paid, they are not consistent to conclude that the barricades and complimentary measures have impacted enough to reduce the conflict through these indicators. There have been instances like Mysuru, Madikeri (WL) and Nagarahole showing reduction in number of cases over the study period. These appear to be the result of the impact of these barriers and also complimentary measures taken up.

4.5.15. Time of receipt of ex-gratia

When elephant raid takes place, there will be various kinds of damages. Apart from physical damages which causes loss to the farmer, he will undergo anxiety and emotionally trauma. The ex-gratia paid in terms of monetary relief is just to support him to regain some kind of normalcy. Though this will not compensate the loss he has undergone, it will definitely help him to some extent. One expects the relief in the form of ex gratia to be paid within reasonable time limit considering the fact that it involves administrative procedures. Assessment of the loss in the field and then compiling the information and seeking the approval from the concerned authorities will take time. Any inordinate delay will further affect the farmer who is already put to difficulties. The following table shows that whether the farmers received the relief of ex-gratia in reasonable time or not, if not how much of time lapse has taken place between the raids and the farmer receiving the relief. It is important that whatever may be the amount of ex gratia, the affected farmer should receive it within a reasonable time. Considering that formalities are involved for the approval in Government, a reasonable time of three months is acceptable. Hence, if the farmer receives the relief within three months, it has been categorized as payment received on time and anything beyond this period is classified as not received in time.

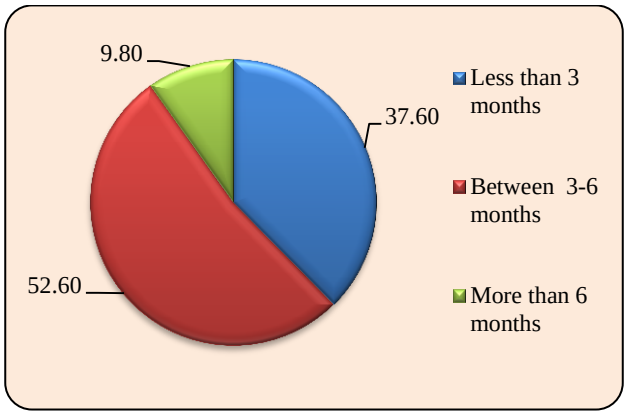
Table-21: Table showing timely receipt of the ex-gratia amount and the time lapse

Percentage of farmers

District	Forest Division	Timely receipt		Time lapse in receipt of ex gratia		
		On Time	Not on time	Less than 3 months	Between 3-6 months	More than 6 months
Ramanagara	Ramanagara	62.3	37.7	62.3	9.5	28.2
Mysuru	Mysuru	-	100.0	-	82.0	18.0
	Hunusuru	100	-	100	-	-
Chamaraja-Nagar*	Chamaraja-nagar	78.8	21.2	78.8	10.9	10.3
Mandya	Mandya	-	100	-	100	-
Kodagu	Madikeri - T	2.2	97.8	2.2	55.9	41.9
	Madikeri – WL	58.3	41.7	-58.3	41.7	-
	Virajpete	74.3	25.7	74.3	25.7	-
	Bandipur	-	100	-	100	-
	Nagarahole	-	100	-	100	-
	Total	**37.60**	**62.4**	**37.6**	**52.6**	**9.8**

Note: "On time" means payment is received within three months.
"Not on time" means payment is received beyond three months
**Chamarajanagar includes the three divisions of BRT, Cauvery and MM Hills*

Time laps in receipt of ex-gratia across all districts is depicted below:



From the table-21 it is observed that only 37.6 % of the affected farmers received the ex-gratia 'On time" which is within a reasonable period of three months. This time of three months is due to the various procedures involved in getting the relief approved. Though the processing of such cases does not involve any delay considering the difficulties farmers have faced. However, any time beyond this is considered as delayed response from the department side. This is important considering that the farmer has already undergone difficulties by incurring economic loss and also emotionally asset back. About 62.4 % of the farmers across the entire study area has not received the ex-gratia on time. This aspect needs to be looked into. It is also observed that now of late, the payment modes have been more streamlined and the affected farmers are receiving the relief well within time. Under 'e-Parihar' a system introduced by the Department, the affected farmers can get all the details and get relief within time. However, it may be noted in case of injury to human the cases are immediately attended and any death due to HEC the relief is immediately made.

Most of the divisions with the exception of Chamarajanagar and Virajpete, the receipt of payment is delayed and in cases of farmers belonging to Mysuru, Mandya, Madikeri, Bandipur and Nagarahole, have received the ex-gratia not on time.

This delay in receiving the ex-gratia range from few months to year. As seen under the time

lapse of receipt of ex gratia, about 37.6 % of the farmers have received within three months of the incident. Rest of the 62.4 % of the farmers received the payment beyond three months period. In this category also, about 9.8 % of them received beyond six months period. Reasons for this inordinate delay is generally attributed to non-availability of funds. The delay is high in case of Ramanagara and Madikeri divisions. Another aspect here is the number of cases in a division and the extent of ex gratia payment to be made. If the cases are more and payment is substantial then probably processing each case may take some time and substantial payments may not be made in one go. These are some of the reasons for the delay also.

The main issue here is the timely payment of compensation and quick disbursement to the grieved farmers however small or large the amount is. The delay could be due to not receiving funds from the government or not distribution to the concerned districts or divisions in time.

It is difficult to project financial outlay on an annual basis for the payment of ex gratia due to HEC. But considering that it has almost become a regular feature in most of the divisions having HEC, a ten percent rise over the previous year expenditure can be normally projected. This ex-gratia payment on time without delay is to be addressed due to reasons already explained in the above paragraphs. There is a need for a fast-track disbursement for this. One suggestion is to allocate a corpus fund for divisions which have huge ex gratia payment and as and when it gets exhausted keep replenishing it in a revolving fund system. This way, the farmers need not wait for the fund sanctions by the Department and Government every time when it gets exhausted. The DFO will have the discretion to enable early disbursement. This can be overcome with further suggestions made in the discussions which can be considered.

4.5.16. Adequacy of amount

Of the problems handling the ex-gratia payment, apart from the delayed payment, inadequate payment as far as the farmer is concerned is a common feature. The farmer feels that the amount paid as ex gratia do not cover all his claims, which of course is difficult to address considering that the relief is more of a support in nature. At the same time, it is difficult to quantify in terms of monetary value all the losses the farmer has incurred both socio and exonymic angle. Thus, the farmer feels that the amount is inadequate in most of the times. Following is the table which shows the percentage of farmers who come under the category who feel whether the amount adequately cover their claims or inadequate.

Table- 22: Table showing Adequacy of amount (ex gratia) received

District	Forest Division	Ex gratia received	
		Adequate	Not adequate
Ramanagara	Ramanagara	61.1	38.9
Mysuru	Mysuru	-	100
	Hunusuru	100	-
Chamarajanagar*	Chamarajanagar	33.9	66.1
Mandya	Mandya	81.2	18.8
Kodagu	Madikeri - T	6.5	93.5
	Madikeri - WL	-	100
	Virajpete	-	100
	Bandipur	-	100
	Nagarahole	-	100
Total		**28.30**	**71.70**

**Chamarajanagar includes the three divisions of BRT, Cauvery and MM Hills*

It is observed from the table that about 71.7 % of the farmers feel that the amount paid as ex gratia is not adequate to cover their losses which in most of the cases perceived to cover the economic losses and not to mention about the social costs. About 28.3 % of the farmers feel that the ex-gratia paid is adequate enough.

Observing some of the divisions like Hunusur where the farmers feel that the ex-gratia is adequate and also the disbursement was within three months, the feeling of good of having received the amount in time makes them satisfied to some extent. Although there is no correlation between the adequacy of the amount and the timely disbursement. However, timely disbursement is very important immaterial of the quantum of ex gratia.

But in most of the other divisions except to some extent in Ramanagara and Chamarajanagar and most part of Mandya and Hunusur, rest of the farmers come under the category of not adequately compensated. Affected farmers around Mysuru, Madikeri, Bandipur and Nagarahole almost all of them feel that the amount of ex gratia is inadequate to cover their losses. Though the rates of compensation are being revised for crops which have been damaged, often they are not realistic and also, they do not cover opportunity costs. Many of the farmers expressed that their loss of well grown coconut, mango and other trees when damaged, the ex-gratia paid do not cover the losses which they have undergone while nurturing the tree and also potential yield of the same. However, as mentioned earlier, ex gratia payment is mainly to support the farmers rather than literally covering all their losses.

But the suggestion that assessment of physical or economic losses can be made by a committee consisting of agriculture and veterinary officials along with Forest may satisfy farmers further and the assessment could be near to realistic. This besides the need for revising the rates of compensation for various items of crops and items in the list. Some of the crops and items have not been included, and this needs to be looked into as those items which ae not included in the list are not entitled for any ex-gratia even if the farmer has incurred loss of that item.

4.5.17 Adequacy of amount and total ex gratia paid

An effort is made to link the total amount of ex gratia paid and the percentage of farmers whether the amount is adequate or not. The following table shows the correlation between the two components.

Table- 23: Table showing Adequacy of compensation and the total amount paid

(*Percentage of farmers)*

District	Total ex gratia paid (Rs.)			Adequacy of amount	
	<2000	2000-3000	>3000	Adequate	Not adequate
Ramanagara	27.2	17.3	55.5	61.1	38.9
Mysuru	40.0	20.0	40.0	-	100
Hunusuru	-	-	100.0	100.0	-
Chamarajanagar*	14.2	19.4	66.4	33.9	66.1
Mandya	18.8	81.2	-	81.2	18.8
Kodagu – Madikeri T	15.1	19.4	65.5	6.5	93.5
Madikei WL	4.2	25.0	70.8	-	100
Virajpete	-	37.1	62.9	-	100
Bandipura	33.6	26.2	40.2	-	100
Nagarahole	-	27.3	72.7	-	100
Total	**15.30**	**27.30**	**57.40**	**28.30**	**71.70**

**Chamarajanagar includes the three divisions of BRT, Cauvery and MM Hills*

It is observed from the table that farmers receiving less than Rs.3000 of ex gratia is around 42.6 % and more than Rs.3000 is around 57.4 %. The farmers feeling that the ex-gratia is inadequate is 71.7 %. Thus overall, there is no correlation observed between the two components across all divisions.

In Ramanagara, with 55.5 % of the farmers receiving ex gratia of more than Rs.3000 and 61.1% of the farmers express that the ex-gratia is adequate. There is some positive correlation between the two components in this district. The same trend is observed in Hunusur also. In the remaining districts /divisions no such trend is observed. Thus, it can be summarized that the adequacy of amount is individually to be seen and across population there is no specific trend that whether the farmers receiving ex gratia more than Rs.3000 may express adequacy of the amount to covering their claims. Each case has to be dealt individually.

The ex-gratia payment involves three components, the quantum of payment, its time of disbursement and whether it is adequate or not. There have been criticisms by the

farmers in most of the cases in the study area that the quantum of payment received is much less than the actual loss incurred. Secondly the time of disbursement. Often the time taken for disbursement is too long. The reasons could be many. It is seen from the data that in all the three areas there has been time gap between the incident of raid happening and the ex-gratia paid. Overall, about 62.4 % of the farmers receiving the ex-gratia delayed between 3- 6 months and beyond. It is observed that sizeable number of farmers who are affected have expressed that the ex-gratia amount paid is inadequate. Overall, for the study areas 71.7 % of the affected farmers expressed that the ex-gratia received is insufficient. There is a need to look into it considering the fact that some of the grown-up crops of coconut gets a compensation of Rs 2000. This rate needs to be revised in consultation with agriculture and horticulture departments. Though it is difficult to compensate the actual loss, somewhat reasonable amounts have to be paid. In this regard, whether insurance agencies will have any role to play needs to be looked into.

The reasons for this delayed payment could be non-receipt of funds from Government and sometimes inadequate funds under ex gratia for that particular year either due to increase in cases and thus having insufficient funds. This aspect can be sorted out. It is also suggested to have a rotational fund made available under this head so that, the affected person need not wait. A suspense or corpus amount can be kept exclusively for ex gratia to be paid for crop and property damages, human deaths and injuries at the disposal of the division and with the e Parihar in practice, one can ensure speedy disposal of the compensation. As and when the amount getting exhausted it can be replenished. This will avoid difficulties to the famers who have already been affected economically.

During the study period, it is observed that substantial percentage of farmers fall in the category of Rs. 3000 and above of ex gratia payment and have expressed it as inadequate. Many of the farmers have also opined that they have not received the ex-gratia on time and there have been delays ranging from 3 moths to a year. However, these gaps have been taken care of by the Department and Government with the

introduction of e- Parihar and also setting aside funds exclusively for payment of ex gratia outside the purview of plan. Further requirements will be replenished depending on the requirement. This will ensure that there is no delay in procuring the funds from Government for payment of ex gratia and also any delay in disbursement due to paucity of funds is addressed. With e Parihar, the affected farmers after assessment of the damage will get the ex-gratia directly into their bank accounts without any delay

4.5.18 Projected physical and financial outlay

The projected figures available from KFD are not complete and two years of 2019-20 and 2020-21 have already passed from the time the evaluation started. Most of the figures includes physical and financial achievements which are already met rather than proposed. Very few divisions have projected figures for the next three years. The projected figures should form two components, construction of barricades including the repair, restoration of old barricades, secondly the ex-gratia amount for crop, property damages, human injuries and deaths. The details are given in Table-24.

Table -24: Projected physical and financial outlay for the five years from 2019-20 to 2023-24 in the districts of the study area

(Physical targets in Km and financial in lakhs of rupees)

Division	2019-20		2020-21		2021-22		2022-23		2023-24	
	Phy	Fin	Phy	Fin	Phy	Fin	Phy	Fin	Phy	Fin
Ramanagar	NA	NA	NA	NA	-	-	-	-	-	-
Mandya	NA	NA	NA	NA						
Mysuru	NA	NA	NA	NA						
Hunusur	NA	NA	NA	NA						
(Chamarajanagar*	4.07	37.9	3.9	40.5	28.15	275.56	-	-	-	-
Madikeri(T)	19.3	584.3	3.7	32.9	47.3	3399.2	79	3047.5	81.0	3666.9
Madikeri (WL)	-	-	-	-	-	5.0	-	28.5	-	22.0
Viajpete	NA	NA	NA	NA						
Bandipur	30.9	1724.0	26.4	532.0	87.2	2229	60	3310	45	3107.5
Nagarahole	16.3	2015.0	56.5	7258.6	8.7	529.7	-	-	-	-

*Pertains to BRT only

However, from the data available it is observed that Madikeri territorial and Wildlife divisions both have increased projection of financial requirements in the coming years. This indicates the need for more barricades and probable increased level of conflict. Madikeri Division has projected considerable increase in their projection from 32.9 lakhs to 3399 lakhs and so also the physical targets projected. Bandipur and Nagarahole also have projected increased financial outlay and the physical targets projected in the coming years. These indicate that the extent of barricades is projected to cover the boundaries in a phased manner and also covers the restoration and repair works of the existing barricades. In addition, the crop compensation projection also needs to be taken into account and the same has not been projected in many divisions.

4.6 Cost Benefit Analysis

The criteria for selection of villages for collecting the data on crop raids and other associated details is taking into consideration the number of raids and the compensation paid thereof. For evaluation of the barricades, sampling of ten percent of each barrier in each range, details of barriers constructed during the period of evaluation is collected and analysed. Location of the barriers sampled may be near a selected village or may not be. Similarly, the village selected may or may not have a barrier constructed during the evaluation period. Further, these villages and presence of barricades may not be located in each range. Thus, selection of villages and the presence or absence of barriers are independent of each other. This was discussed with KEA during the selection of villages as the selection of village was done randomly after listing all the villages which have had raids in each district/Division. As selecting villages without raids will not serve the purpose. In addition, selection of villages where the barriers are also located will result in biased sampling and also may not give true picture. Hence the criteria for selection of villages and the barrier for sampling are independent.

In such cases, arriving at barrier wise cost benefit analysis would be difficult as the barrier constructed and the selected village/ farms location where raids have taken place are not correlated. The location of farms is at a distance from the EPT and Rail

fence constructed which are on the boundary of Forests. However, an attempt is made to work out cost benefit analysis of EPT and Rail fence taking into consideration near by farms located (which could be few kilometres away). As far as Solar fence is concerned since the farmers have gone for fencing their farms after availing subsidy, the cost benefit analysis has been worked out.

In addition, other variable factors such as cropping pattern, irrigation facilities before and after erecting of barriers are not being uniform will also have to be taken into consideration

With these limitations, cost benefit analysis has been carried out for Solar Fencing to estimate the benefit accrued against investment made on these barriers

4.6.1 Solar Fencing

Solar fencing is one of the sustainable means of protection as the energy is provided by solar energy and as the agricultural farms often attacked by elements may be remote in location, there may not be availability of electricity and even if available, may not be available 24 X 7 all through the year.

This study is a modest attempt to find the economic feasibility of solar fencing to mitigate crop damage due to elephant menace, employing discounted benefit cost ratio technique and the concept of incremental income. For the estimation of discounted benefit cost ratio (DBCR), the information on costs incurred and returns realized by farmers from farming over a time period is required.

Considering the base data of six sample farmers from Chamarajanagar district, as the details were limited, the cropping pattern of the District has been used presuming that the farmers by and large follow similar cropping pattern (as indicated in Table-25.1). The data on cost of cultivation of crops per acre was obtained from different studies (Patil, 2014, KAPC report 2019-20). The returns were estimated considering the productivity of crops and the market price for the latest available year (2019-20).

The data on crop damage due to elephant attack on farms was obtained as Rs. 6548 per acre for the current year assuming the inflation rate of 6% (Venkataramana *et al* 2017). The various data on cost and returns were compounded to the current year 2022 for the comparative basis.

Discounted Benefit Cost Ratio

Considering the marginal crop damage as Rs. 6548 per acre, due to use of solar fencing, the likely damage of Rs. 6548 per acre saved is accruable to farmers as returns. The investment on solar fencing is around Rs. 22310 per acre and the amortized cost of solar fencing with an assumed life span of five years at the rate of 6 percent (equal to inflation rate) works to Rs. 5296 per year. Thus, while the additional cost of solar fencing per year works to Rs. 5296 per acre, the additional returns equal to marginal damage cost saved works to Rs. 6548 per acre.

The stream of costs and returns was simulated for five years assuming three normal years and two bad years to reflect the ground realities . The discounted benefit cost ratio due to use of solar fencing intervention, worked out to 1.28 (Table-25.2). Accordingly it is an economically viable intervention to mitigate the attack by elephants

Table 25.1: Estimates of Costs and returns of sample farmers (n=6)

Crops cultivated	Area (acres)	Productivity (quintals per acre)	Production on sample farms	Price per quintal (Rs)	Gross returns (Rs.)	Cost of cultivation per acre (Rs.)	Total Cost (Rs.)
Maize (Qtl)	9.23	31.1	287.053	1848	530473	24914	229956
Horse gram (Qtl)	3.95	2.68	10.586	3000	31758	7462	29474
Sugar cane (tons)	0.81	42.75	34.6275	3185	110288	88500	71685
Tomato (tons)	0.57	9.73	5.5461	10230	56736	112006	63843
Chilli (tons)	0.57	5.6	3.192	11340	36197	80367	45809
Beans (tons)	0.57	4.22	2.4054	31000	74567	112176	63940
Coconut	1.356	4000	5424	12	65088	32000	43392

Crops cultivated	Area (acres)	Productivity (quintals per acre)	Production on sample farms	Price per quintal (Rs)	Gross returns (Rs.)	Cost of cultivation per acre (Rs.)	Total Cost (Rs.)
(No.)							
Banana (tons)	1.44	10	14.4	11344	163353	113274	163114
Marigold (tons)	1.67	8	13.36	30000	400800	173688	290059
Cotton (Qtl)	1.48	3.24	4.7952	5020	24071	34977	51765
Total					**1493335**		**1053041**

Table 25.2 :Estimates of discounted benefit cost

(Amt. in Rs.)

Year	Costs	Returns	Discount factor at 12%	Discounted costs	Discounted benefits	Net cash flow
1	1187294	1659327	0.892857	1060084	1481542	421458
2	1258532	1758887	0.797194	1003294	1402174	398879
3	1334044	1653354	0.71178	949545	1176824	227278
4	1414086	1752555	0.635518	898677	1113780	215102
5	1498931	1647401	0.567427	850534	934779.8	84245
					DBCR	**1.28**

Incremental Income

Incremental income is the difference between additional returns and additional costs due to the intervention of solar fencing. The additional cost incurred towards solar fencing is the amortized cost of solar fencing equal to Rs. 5296 assuming life span of solar fence as five years. Additional returns due to solar fencing is the savings in the damage cost which works to Rs. 6548 for 2022. Hence, the incremental income due to solar fencing is Rs. 1252 per acre (Table 25.3). As the incremental income is positive, solar fencing is economically feasible.

Table 25.3 :Incremental income due to solar fencing to sample farmers

Particulars	Value (Rs.)
Average cost of fencing per meter	115
Average length of fencing per acre (mts)	194
Cost of fencing per acre @ Rs 115 per meter	22310
Amortized cost of fencing per acre assuming five years of life span	5296
Savings in damage cost due to elephant menance per acre	6548
Incremental income (savings in damage cost minus amortized cost of fencing per acre)	**1252**

References

GV Venkataramana, Sreenivasa and HG Lingaraju, 2017 and Kiran K R P 2014.

4.6.2 Solar Fencing – Individual V/s. Community Effort

Solar fencing has been ana effective barricade in most of the places where it is erected. Farmers have realised its benefits and have started taking up for their farms. Erecting solar fence has resulted in savings accrued resulting in an economically viable option on a long-term basis. This not only reduces the conflict and over a period of time the damages which otherwise could have occurred due to conflict will also be prevented and thus adding on to the overall benefits of using solar fencing. In addition, the use of soar fencing adds on positive incremental benefit, which is economically viable to use it in the long run.

Data collected from few places on individual and community solar fencing erected by farmers with the help subsidised by Government has been done. Individual farmers get a subsidy of 50 % of the cost of fencing by the Forest Department. The farmers have observed the benefits of erecting and maintaining the solar fence around their farms and thus have resorted to erecting the same in HEC areas. It is observed that even farmers with small areas have availed the benefit in conflict prone areas. Availing the benefits for lengths of 500 – 700 M and one kilometre and more is quite common.

Another observation is that most of the individual farmers have gone for fencing their farms on one side of the boundary which is mostly prone for damages by elephants. This still leaves a gap unless the fencing is continuous one including the adjoining farms. However, with the gaps in between the farms the crop damages are still prone for elephant attacks. In such cases continuous fencing all along the boundary of such farms collectively which are generally prone for crop damages will reduce the conflict. The benefit of community fencing all along the boundary on at least two sides which are prone for crop damages can be addressed. Fencing of individual farms are generally taken up on one side of the boundary only and the other side which may also be vulnerable is still a gap. Hence, community fencing for large areas with combined farms will ensure better protection and coverage than individual farms. In addition, farmers coming together for community fencing can maintain the solar fencing collectively together in a more efficient manner. Community fencing for large areas collectively will reduce the conflict and benefit the farmers. In such cases Government may also consider offering higher subsidy that the existing ones will encourage farmers to take up solar fencing.

4.7 Complementary measures

In areas where the boundary between forests and agriculture are diffused and not clear, protecting the crops and reducing the mitigation is challenging. Fragmented patches of forests interspersed with agriculture and human habitation in such areas it is difficult to protect crops and reduce the conflict. In such areas probably protection of agriculture fields through barricades such as solar fence can be thought of rather than barricading the interface.

Ecological loss which is mainly due to loss and fragmentation of habitat resulting in eventual loss of diversity of flora and fauna. The key lies in Identifying the factors causing these as many of them could be site or area specific and then addressing them is a priority. The elephant bearing areas and the PAs are having sustainable programs to not only arrest the ecological loss but also has addressed the issues of habitat improvement.

As the interface is the crucial issue for mitigating the HEC, some of the complimentary measures can change the interface in managing the conflict.

4.7.1 Alternate crops: Growing crops that are not preferred by elephants such as mulberry, chilly, Citrus. These will not only minimize the HEC but also minimizes the damages. This needs to take into account the socio-economic condition of the farmer. However, during the survey though many opined that they need to discourage growing crops which are preferred by elephants, farmers did not show keen ness in going for any alternate crops.

However, growing these crops which are not preferred by elephants as buffer crop between their normal growing crops such as paddy, is another option but, unless these areas are of substantial width, which most of the farmers will not be in a position to accept, it may not serve the purpose.

4.7.2 Change in land use: To minimize the HEC, if the land use is modified from one of agriculture to some other activity, then HEC can be reduced. But the farmers are not wiling for any land use change.

4.7.3. Guarding: Widely practiced method of protecting the crops at night. Though of late the practice has declined but still many of the farmers in the study areas practice this and do night watch of the crops. Either they do night watch by having a machan and watch. The other method is night patrolling with the community on rotation basis.

Once the elephants are detected of having entered the field then to drive them away with the help of the department officials is done by :

1. Making noise by shouting, beating drums, firecrackers,
2. Use of stones to throw and driving them away.
3. Use of chilly smoke and this has limitations.
4. Fire is used to deter elephants from entering the agriculture fields. Use of electric torch, Kerosene torch are commonly used
5. Use of thorny plants like thorny bamboo as a hedge plant as a preventive measure

6. Use of barbed wire fence has limited use in deterring the elephants.
7. Use of chilly – grease fences are known to repel the elephants. But in the surveyed area, no such measures are employed.
8. Bee sound as a repellent measure is used in other countries.
9. Bee hive fences are also used
10. Drones are used to drive away the elephants and because of buzz of drone.
11. Trip alarms and Sensor based alarms are used as a forewarning measure.

4.7.4 Wild Eye and its application by the KFD

The NGO RESOLVE and the AI software company CVEDIA have come out with a novel idea to reduce the Huma Elephant conflict by way of early detection before the damage occurs. This conflict has put tremendous pressure on marginal farmers in the area.

A scalable solution to this challenge requires a low-cost technology to detect elephants and transmit alerts to wildlife managers and communities to prevent conflict situations before they occur. Using new advances in artificial intelligence technology, RESOLVE's camera system, called **Wild Eyes™ AI**, now enters the field. The small cameras work remotely, hidden in a tree above the reach of elephants, and when the camera's motion sensor is triggered, it uses computer vision to detect elephants in the frame and transmits those images in near-real time to the cell phones of village guardians

A sophisticated AI algorithm detects elephants based on synthetic data models created by CVEDIA, running on the Intel Movidius vision processing unit (VPU) embedded in the Wild Eyes AI camera. The camera remains asleep until the motion sensor is triggered and then, leveraging the AI algorithm, the Intel VPU filters out false triggers. By filtering "on the edge" i.e., only transmitting true positives of elephants, the camera conserves vital battery life. Due to the VPU's low power requirements, Wild Eyes AI can run for more than 1.5 years on a single charge of its small rechargeable Lithium-Ion battery—a game changer for a field-based sensor. The image of the elephants can be sent over a GSM network, or via a long-range radio link in areas without cell connectivity, in under two minutes from the camera,

to the Internet, and back to the local guardians, completing the loop.
The AI elephant detector can also be used to advance the management of elephant populations in tropical forests.
The company has conservation oriented solutions that might be relevant to your use case although neither is a perfect fit right now.

The first is the Elephant survey system and is intended to be used to find and count elephants in survey imagery captured from a great height.

The second is Trap Tagger. This is a system that is used to find and recognise a range of species (including elephants) in imagery captured by camera traps in the wild.

The obvious issue with using either of these in your application is that both are intended to be used with human supervision and neither operates in real-time. Having said that we have made an API available before for a user who needed to integrate our species classification results in a larger system. We might be able to male something similar available for you, but it won't be a complete solution. You would still need to figure out how to get the images from the source to our API in real time and how to react to any Elephant recognitions that we might produce. There are other caveats too (eg. both systems have been trained and used in Southern African biomes, so would need adaptation).

RESOLVE is a Washington, DC-based non-profit organization that forges sustainable solutions to critical environmental, social, and health, challenges by creating innovative partnerships where they are least likely and most needed. RESOLVE's Biodiversity and Wildlife Solutions Program tackles the most pressing conservation problems of our time – the approaching extinction of endangered wildlife and threats to habitats, including tropical forests where most of the world's species reside – through technological innovation, ambitious global agreements, and targeted land protection
CVEDIA is an AI solutions company creating machine learning algorithms for applications where data is limited or unavailable. We've mastered synthetic data for

computer vision, using a combination of data science and machine learning against a backdrop of 3D design.

For further details contact Hannes Naude – hannes@innoventix.co.za., nic@innoventix.co.za

4.8 Elephant Corridors:

The state has some identified Elephant corridors connecting network of PA's. In 2016, the department has identified Ramadevara Betta – Chowarkal elephant corridor connecting Bannerghatta NP and Muggur of Cauvery WLS as a critical corridor. The area identified as corridor falls within the boundaries of both PA's. It is proposed to enrich the habitat of the corridor and also procure private lands to reduce the conflict and also maintain the corridor.

Additional information

1. Information from Villagers, leading persons from the village and FGD
2. Information from Forest personnel at field level
3. Information from officers of KFD at supervisory level

Ecological restoration of existing natural elephant habitats and its migratory routes are managed better. Elephant corridors are very important considering that elephant populations occur very much outside the PA's. These corridors will act as relatively narrow linear patches of vegetation forming vital linkages between larger forest patches. They allow free movement of elephants between different habitats without being disturbed. Programs such as habitat enrichment and improvement can be taken up on a landscape basis after duly identifying the various habitats and connectivity's. For this very effort, it is suggested to have a blue print at state level as well as at district /Division/Range level for effective implementation of the programs. Maintaining these corridors will facilitate the movement of populations and also exchange and maintain genetic diversity. Corridors are considered as a cost-effective reliable strategy to conserve populations of wide-ranging species and promote gene

flow for all species, and thus allow species to adapt to climate change.

It is well known that large tracts or areas of habitat are better and ideal than smaller and fragmented areas. If these smaller patches of habitat are closer together, better it is than those that are farther apart. If these are isolated habitat patches, then connecting these with a corridor are better than those without any link.

A biological corridor is a habitat which will nurture the species in all its different stages, in this case, the reference is to Elephants. When two or three PAs are separated by different land use classes and there is a need for connecting these habitats through a corridor which ideally provides a good habitat for elephants. Corridors are the best way to connect isolated populations. These corridors which are naturally existing will help in ecological processes and maintain regional and local biological diversity. These corridors facilitate the movement of populations and also exchange and eventually maintain genetic diversity. Corridors are considered as a cost-effective reliable strategy to conserve populations of wide-ranging species and promote gene flow for all species, and thus allow species to adapt to climate change.

Elephant corridors such as Chamarajnagar – Talamalai forests at Muddahalli have been prioritised as top, Karadikkal- Madeswara is another identified corridor.

Restoring connectivity of these corridors is important to overcome the effects on biodiversity due to loss of habitat and fragmentation. One of the main approaches to rejuvenate is to go in for multi species package rather than focusing on single species. These patches will eventually need to merge with the habitats which are connected. Identifying flag ship species and the umbrella species and if these habitat patches are connected, they will eventually support the range of species including Elephants. Thus, the main approach would be choice of multi species which are native to the area and will harbour range of species including elephants. The movement of elephants within the PA s in the state as well as between the states is well known in the border districts. Various corridors have been restored especially which are crucial to the

movement of the elephants. Further efforts are on to restore as many as possible. But it is relatively easier to connect the habitats when two PAs are separated by a degraded patch, and the same can be restored and rejuvenated with appropriate measures by interventions which includes closure of areas for human disturbances, promoting natural vegetation and then planting of multi species which are native to the area keeping in mind the flag ship and umbrella species.

4.9 Use of Repellant Crops

Repellent crops being grown as one of the complimentary measures taken to mitigate the conflict. As observed in some areas few crops such as mulberry, citrus and sun flower are not damaged due to crop raids. Though these are not used as repellent crops, but grown as regular crops in the cropping pattern. To grow repellent crops like chillies and other repellents crops, the width has to be substantial. Considering the data collected on the extent of damage to the crops, about 55 % of the area damaged is between 0.5 -1.0 acre, probably indicating that these farms are mostly being small and marginal farmers, the affordability to go for repellent crops in the borders and then for their main crop is a question**.** In such cases barricades will help in reducing the conflict and damages due to raids.

Elephants are having keen olfactory sensors by which they can smell a ripening paddy crop and raid. Studies have shown that in Sri Lanka they have tried to mask the smell of the ripening paddy with other crops so that elephants will not be able to gauge the smell of paddy for raids. Elsewhere in Africa crops like Ginger, Onion, Garlic and Lemon grass were tried in areas known for frequent raids and the damages in such cases is mainly due to trampling and not due to raids. Though cultivation of such unpalatable crops as buffer on a large scale is yet to be taken up and also these crops have to fit into the cropping pattern in those areas. Even if these crops are not raided but still there will be loss due to trampling of these crops in different stages.

However, Suggestion of appropriate choice of repellent crops can be done by Agriculture Department taking into consideration the farmers requirement and site

conditions. Further suggestions can be made regarding repellent crops. But these measures are only temporary and may not sustain for longer periods.

4.10 Information from Villagers and FGD

Further ancillary data was collected (through Annexure 2), from the affected farmers gave an insight to what the farmers think and feel about the conflict and the assistance extended by Department and also their own initiatives in managing the conflict. Further, their opinion and suggestions to reduce the conflict. The assistance of and initiatives by the Forest department and district administration of involving the villagers to mitigate the conflict., these observations are as follows.

4.10.1 Regarding barricades: Most of the affected farmers are of the opinion that barricades do reduce the conflict and they needs more barricades. Many expressed the barricades are constructed and are not maintained afterwards making it defunct or ineffective. Among the type of barricades, most of them feel EPT and Solar fence in combination is effective. With the usage of Rail fence in many places, many of them feel that this type of barricade is more effective. In places like Madikeri, due to heavy rains, barricades like EPT have become defunct due to non-maintenance. Many of the farmers have taken the initiative of barricading their farms with solar fence either on their own or through the subsidy facilities offered by the Department. Some of them have gone for barbed wire fencing. Overall farmers feel that barricades are quite effective and needs to be taken up by the department in a more systematic and planned manner without much gaps in the boundary. Generally, while setting up a barricade in the interface of a village and forest boundary, the forest department discuss with them and take up the work.

Some of the observations of the farmers are genuine to the extent that the barricades are not maintained properly and eventually making them ineffective. At the same time to cover the boundaries and areas interface with villages cannot be catered with barricades as the boundaries may not be continuous. Barricading fragmented patches is

not tenable as in places like Ramangara, Mysuru, Hunusur and Mandya the forest patches are interspersed with agriculture and human habitation. However, in areas with continuous forest tracts as seen in Chamarajanagar, Bandipur and Nagarahole the barricades are continuous and effective. With the use of rail fence the conflict has reduced somewhat and that is one of the reasons the farmers feel that rail fence will reduce the conflict and is more effective than other barricades. But rail fence cannot be used everywhere as it has limitations of site and also the cost involved.

Villagers feel many times the elephants cross the barricades and enter the villages. This could be due to either lack of maintenance or not having a continuous barricade in the interface area. Also, the gaps in the boundary without barricades needs to be taken up immediately.

There was an effort to involve the farmers and community to maintain the barricades and many have opined that with proper training and monetary incentive they are willing to maintain the barricades near their villages. In the absence of any regular maintenance arrangement, the department may look into this and involve community in maintaining the barricades as villagers are also stake holders in the entire process. As many of them have set up solar fence for their farms, they are maintaining the same. Hence, training them for maintenance is not a difficult task. However, many farmers feel that it is the work of the forest department to manage the conflict and they do not show much interest in most of the activities. Here, it is important to make them understand that they are also the stake holders in the entire process and their initiatives and involvement is also necessary to manage the conflict.

At present, there is a subsidy to farmers to erect solar fence with an area of 0.4 to 10 hectares holding on a 50 – 50 basis. This is applicable for lands located within 5 km from the forest boundary. Those farmers who avail this facility, shall not prefer claims for ex gratia in coming years. This needs to be looked into to arrive at a reasonable period considering the life span of these barricades and its maintenance.

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<tr><td>F G D is in progress</td><td>Meeting at Hanur Range</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Interaction meeting with farmers</td><td>Interaction meeting with villagers in Chamarajanagara</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Interaction meeting with villagers in Sirugur Range</td><td>Interaction meeting with villagers in Kollapura Nanjanagudu</td></tr>
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4.10.2 Cropping Pattern: Most of the farmers in Ramanagara, Mysuru, Hunusuru and Mandya and Chamarajanagar, adjoining areas of Bandipur and Nagarahole grow field crops such as Ragi, paddy, gram, sugarcane, jowar. Among the commercial crops, Banana, mango, coconut and arecanut is common. The farmers expressed that they have been growing these crops for a long time and the increased cases of elephant raids is of late. However, with the improvement in the facilities like irrigation, there has been a slight shift from growing field crops to commercial crops like banana, mango and coconut. Some of these changed cropping patterns and availability of crops

throughout the year and some of the crops being attractants to elephants have also added on to the problem of conflict.

Many of the farmers have opined that they need to discourage from growing those crops which might attract elephants like Banana. But at the same time, they are not interested in changing any of their cropping patterns or crops and also the buffer cropping. In areas like Kodagu, most of the crops grown are plantation crops like coffee, cardamum, pepper and paddy. These ae permanent ones, these cropping patterns cannot be altered. It is also observed that in Channapatna Taluk, growing of crops like mulberry has benefitted the farmers as elephants do not prefer these crops. But in these areas the crop fit into their agricultural activities as it is silk worm growing area. not in places because of severity of raids which are also continuous some of the farmers have discontinued cultivation in their farms.

At present many of the farmers growing commercial crops like Banana, sugarcane, mango coconut adjoining forest boundaries. Suggestion will be made to grow at least 5-10 rows of crops like chilli, tobacco, sun flower all along the boundary. But most of the farmers are not interested in such crops. Ensuring the involvement of Department of agriculture in creating awareness and training program in such areas is necessary.

4.10.3. Community involvement

The involvement of the villagers in mitigating the conflict is important and possibility of involving them at every stage is crucial. It is essential that the village community is made to understand that they are also stake holders in managing the conflict. The FD provides facilities to mitigate the conflict but alone it is not possible with the rise in the HEC. The involvement should start from discussion with them regarding the setting up of barricades which in most of the cases being done. The next step is community network. The FD should take the initiative of forming a network with selected people (youth) from the village and form a network of communication for early warning of elephant and possible raids. This network and putting it in place will go a long way in preventing the conflict and reducing the losses eventually. The villagers can forewarn the Department about the impending raids so that the anti-

depredation squads can drive away the elephants along with the villagers.

Many of the villagers are not taking any forewarning measures and many are not interested in involving themselves in activities to reduce the conflict. Apart from educating and creating awareness about the preventive steps in mitigating the conflict, wherever possible, there should be some incentive mechanism for their involvement. FD has made some attempts to create awareness by conducting roadside shows and publicity in the villages about the conflict and ways to reduce it. These programs should be an integral part of awareness creation in HEC programs as much as ex gratia payments. Many of the interior villages may not have network facilities in which case human network communication needs to be established. The network can be through 'WhatsApp' or any other mode through which early warning and forewarning mechanism of impending elephant raids in the village to be communicated.

Community involvement is ensured at all stages, starting from providing employment opportunities through engaging local youth in anti-depredation squads, anti-poaching squads, watchers and other job opportunities. In addition, at the village panchayat level funds have been given to maintain the barricades with the help of KFD personnel. Local youths are formed into groups and are being utilised in early detection and awareness creation activities regarding elephant conflicts.

The different stake holders in the Human Elephant conflict have been highlighted in the discussions. State Government, farmers/villagers, NGOs are the main stake holders. Their role in mitigating the conflict has been brought out through various interactions with farmers who have been affected by the conflict and their role and suggestions and opinions are taken into account and has been explained in the relevant chapter. Apart from the farmers, the villagers and the societies and knowledgeable persons in the villages have been interviewed to elicit their opinion and role and suggestions to mitigate the conflict has been brought out. Involvement of the community at every stage has been one of the recommendations made and various village level institutions are already involved in several programs to minimise the conflict. These have been brought out in the recommendations.

4.10.4. Facilities for villagers

Along with the preventive mechanisms of HEC, efforts to protect the lives, property and crops of the Villagers needs to be addressed. To enable this, villagers are to be provided with some facilities so that they join hands with the department in driving away the elephants and also to enable them for early warning mechanism. In this regard, setting up a watch tower in crucial areas, kind of a sensor mechanism when elephants enter in a particular route to raid the cropped fields. Providing the villagers with drums, crackers, torch lights.

Organizing training mechanism in maintaining the barricades, in the process of early warning systems and also in driving the elephants without any damage to human lives. Many of the farmers feel the staff attending to HEC are inadequate and there is a need for more man power. This needs to be looked into by the department

4.10.5. Ex gratia payment

Farmers expressed their opinion about the ex-gratia payment made to the affected farmers. Most of them feel that the assessment of the loss mainly economic is not realistic and the amount given as compensation for the crops lost is inadequate. Though revision of rates is done, they want to be compensated in a more realistic way. Due consideration to be given to adequately compensate some of the crops like coconut, Mango and other plantation crops which would have fetched them returns in the long run. Farmers feel that the ex-gratia payment has to be immediate without any delay. For this a mechanism has already been suggested earlier.

Meeting at Talacuavery Range with Villagers

Meeting with Nagarahole Division and FD officials

4.11. Information from Forest Department personnel at field level

The department officials at the field level starting from Forest guards, Deputy RFO's and RFO's who are working at the field level handling the HEC their opinions are also taken through an approved schedule. Following are the observations from the personnel.

Meeting with Ramanagara FD officials

Meeting with villagers at Madikeri WL division

Meeting with villagers in Muggur WL range

Elephant movement is mainly in summer and when they are stressed for want of food and water then they foray into other areas including crop fields. Although the movement is in regular routes often, they tend to stray in search of food and water. At places, where barricades have been set up, elephants have changed the routes and it has become difficult to trace and monitor those changed routes.

Meeting with Villagers

There is a need for studies to be taken up on the carrying capacity of different habitats. Need for a separate study to be taken up on elephant population in coffee estates. Habitat enrichment in areas wherever possible needs to be taken up.

Regarding barricades, rail fence is one of the best to deter the elephants from raids. But they also feel that it cannot be erected in all the places. Solar and EPT

combination has given good results. The problem with maintenance is inadequate funds or no maintenance funds after construction of EPT. There has to be an in-built mechanism of maintenance for a minimum period of three tears after construction. Of late some of the agencies have been given maintenance. There is a suggestion to revise the height and gap of the rail fence as it has been observed in many cases, elephants are escaping through the gaps in the middle. At present the gap is 3 feet which some personnel feel to be reduced to 2.5 feet and rising the height from 6 feet to 8 feet. But this will increase the cost substantially.

There is a need to set up a full fledge Anti Depredation Squad (ADS) in almost all areas where HEC is there. They should be provided with vehicles and has to be exclusively engaged in preventing and protecting the HEC. This should precede with adequate man power in the ranges. As of now, many of the Ranges have shortage of man power. This ADS has to be equipped with all facilities to handle HEC. Providing surveillance drones and other related equipment for better monitoring of elephant herd movement is necessary.

The ex-gratia payment needs to be streamlined by setting up a special fund so that there is no delay in disbursement of ex gratia. At present the delay is mainly due to non-receipt of funds in time. It is already suggested to have a corpus fund which can be rotated to avoid any delay.

Discussion with Higher officials of the Department

Discussion with PCCF Wild life and APCCF Wildlife has given an idea about the policy level measures and need for its systematic implementation at field level. Following is the outcome of the discussion on few pertinent points

Policy measures to reduce the conflict has been mainly through the physical barriers which are taken up on large scale covering the forest boundaries in a phased manner. These barriers are EPT, Solar fence and Rail Fence. In areas where required, combination of these have been taken up. While taking up these barricades, priority is given first to repair, modify and bring back those barricades already constructed into a

functional status and then taking up new ones.

Any gaps in the barricades constructed in a phased manner is being addressed on priority. The gaps are covered with other barricades such as EPT or mostly solar fence to attend the gap and ensure that there is no gap which can be exploited by elephants. Engaging technical personnel to check the barricades on a regular basis and scientifically attend wherever special structures are required on site specific requirements and even those which need repair and maintenance is being monitored by technical personnel who are engaged by the department.

Regarding rail fence, procurement costs are very high, possibility of getting the rails at concessional rates are to be explored, which will reduce the cost of rail fence. Construction of rail fence barricades are being given on turn key basis so that construction, maintenance will be looked after. Persons from anti depredation squads are being engaged in monitoring the barricades on distance basis allocation for effective monitoring. But still there is a need for institutionalising the mechanism for efficient management of these and reducing the conflict.

Regarding corridors, for populations within its natural habitats the corridors are being maintained and those which are connecting network of PA's or elephant habitats within the PA's the condors are being maintained by enrichment and other activities. Within the habitat of population and landscape if there are any fragments efforts to connect the same and maintenance is being addressed. But between populations covering large area corridors maintaining may not be tenable.

Elephants have been foraging in the habitat as well as in the adjoining crop fields all the time and the degree varies from habitat to habitat. With the construction of barricades, elephant movement and foraging outside has taken new routes and are in search of new areas. Also, often confinement of some of these populations in its habitat has resulted in competition for food and water and unable to foray freely outside these areas has resulted in kind of stress on elephants.

Although mapping of severity or vulnerable zones are not prepared, there is need for

one to act as a guiding factor for implementation of various measures. The basis for this is manly the ex-gratia paid and number of crop and property raid cases.

Regarding land use changes in the vicinity of the forest boundaries, creating awareness on the HEC. And role of complimentary measures of discouraging crops which are attractants to elephants is being attempted. Role of agriculture department in convincing the farmers about the alternate crops to those which attract elephants and their economics need to be made understood by farmers and may be result oriented demonstrations can go a long way in convincing he farmers to change of cropping pattern and reduce HEC

Regarding setting up of corpus fund for compensation payment and enable timely payment, it has been streamlined with Government by delinking the amount allocated for HEC compensation from the regular annual allotment for other works of the department and these funds are set aside at the disposal of the department to be distributed to all divisions. The same will be replenished after the usage of the initial allotment made. At the same time e- Parihar which is in place now enables the immediate disposal of funds directly to the affected farmers account through treasury once the bills are submitted to the treasury. By this process, delay in payment of ex gratia is avoided.

Regarding the existing crop insurance norms, the rider is that the damage should be 30% and above for consideration. Issues like who will pay premium and how much to pay and the damages may exceed and the number of cases and payment of compensation needs to be addressed.

Community involvement in maintenance of the barricades is being taken up on a trial basis by depositing the maintenance amount with the panchayat and then maintaining by the villagers. Those who fail to do this, will not get any ex-gratia due to elephant damages. This is to ensure that they attend to the maintenance properly for which amount is made available. But the results are yet to be seen.

After discussion with PCCF (WL) it is informed that NREGA funds can be used for

habitat improvement as these activities are not fully dependent on availability of funds. But for other activities such as procuring materials and labour charges involved in the activities, unless this work is continuous without being affected, then only it can be taken up under NREGA funds. Procurement of material at a particular stage can be taken up in a coordinated manner and can be planned by approaching the Department. However, Department is open to the idea of using the funds for various purposes including the habitat improvement in addition to its own funds.

On discussion with PCCF (WL) it was brought out that Lantana, Eupatorium and other herbs are troublesome and these can be removed only mechanically and not manually. Once these are removed, then seed broadcasting or planting up is easier and can be taken up. The work of removing these weeds have already been taken up in few Protected Areas involving Taluk and Panchayat institutions. Expression of interest has been floated on no profit basis with the condition that once Lantana is removed it has to be transported out of the area by the person. These are being tried in BRT, Bandipur and Nagarhole on trial basis

4.12 Case Studies

Case Study -1: Mosaic pattern landscape and fragmented forest

District: Ramanagara, Taluk: Channapatna, Forest Range: Channapatna

Location and features:

Ramanagara district has a forest area of 414.54 Sq. km mostly dry deciduous and scrub type. In most of the area it is fragmented except the one adjoining Bannerghatta NP and Cauvery WLS. Earlier studies show that Ramangara has an average estimated population of 251 and with a density of 0.7 per Sq. km as against the state average of 0.6 per sq km. This indicates that this population might be exerting pressure on the resources in the natural habitat. This particular case study pertains to two villages, B V Halli and Ammalidoddi in Channapatna Taluk under Channapatna range. In this area it is observed that there are two patches of forest. Thenginakallu State Forest having an area 2579 hectares and Narikalgudda State Forest with approximately 1500 ha. Villages B V halli and Ammalli Doddi are located between these two patches of

forests (Map shown).

In the Channapatna Range, there are four sampled villages and the two of them, Ammalidoddi and B V Halli have been visited during pilot study also. In both the villages maximum of ten crop damage cases have been sampled. In the entire range, all the four villagers have maximum of ten cases sampled for crop damage cases. Ammalli doddi is at a distance of about 1.5 - 2.0 km from forests boundary.B V Halli village is located at a distance of 0.5 km from forest boundary.

Crops grown are Ragi and Coconut, Paddy, Maize, Banana, Mulberry and Mango. The affected farms are located at a distance of 0.5 -1.5 km from forest boundary. Boundaries are discontinuous and diffused.

Problems

Crop raids are common feature throughout the year with peak season between May and September. The crop raided area ranges from 0.3 – 2.0 acre in individual cases. The number of cases in BV halli is on the rise compared to 2014-15. Department officials and the villagers have informed that the movement of elephants is happening in the regular route. Elephants' habitat in these two SF and keep moving between these SF's. In the last few years, the landscape of the area changed, and is now interspersed with agriculture and habitation. This was mainly due to irrigation facilities and the farmers have gone for more commercial crops like Coconut, Mango. Besides this, there will be some or the other crops throughout the year. The elephants though a small herd continue to move in the same way as before following its regular route. With lush crops throughout the year and availability of water, the elephants known to come down from these SF during evenings and night and attack the crops and return to the habitats. In all seasons the elephant movement is regular in these areas. Elephants generally come in search of forage and water.

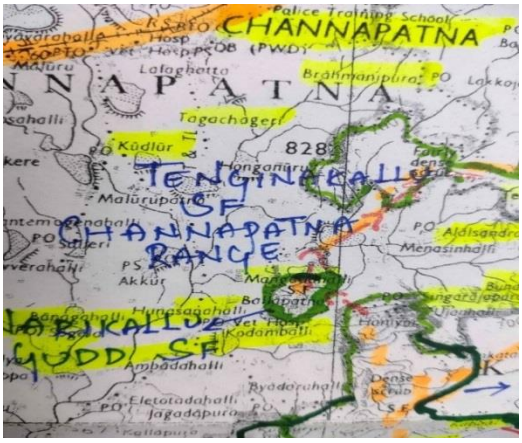
Crop damages is more between the months of May and Sep. Most of the damages is to the extent of 50 -90 % range indicating the intensity. Both commercial and non-commercial crops have been damaged. Severity of conflict is graded as severe. Many

farmers have left the land fallow due to incessant crop damages

Crop damage cases in Channapatna Range for the study period

Year	Crop damage cases	Total ex gratia paid (Rs.in lakhs)
2014-15	136	6.11
2015-16	77	4.40
2016-17	118	8.66
2017-18	353	28.90
2018-19	472	26.17

From the above table it can be seen that from 2017-18 the number of crop damage cases is on the rise in the entire Range and the amount of ex gratia has also on the rise. This indicates that probably change in the landscape in the area could be the reason behind.



Measures

Measures taken are mainly short term by way of EPT and Solar fencing. EPT is working to some extent. Solar fences have been damaged. In B V Halli, EPT has been constructed in 2019-20. Solar constructed during 2014-15 of 1 km length at a cost of Rs. 2.57 lakhs is rendered ineffective and abandoned also. Non-maintenance and lack of funds for maintenance has been the reason. Growing mulberry has reduced the damage and generally not raided by elephants. The farmers are interested in community solar fencing for their farms. Some famers are of the opinion that the elephants should be confined to their natural habitats, while some say they need to be trans located. Many times, farmersare not aware that they are also stake holders in

the HEC. Awareness has to be created and they should involve the community at every stage.

It is observed that a small percentage of the population in the district repeatedly involved in crop raids and more or less the same locations are mainly affected. This may be an indication that it is probably the migratory route of the elephants. Before the change in the landscape with agriculture, the two fragmented patches were probably connected with *Gomal* lands. The problems aggravated once the landscape changed to forest patches interspersed with agriculture and habitation.

Permanent measures such as restoring the corridors will go a long way in minimizing the problem of conflict.

Studies on the carrying capacity and density of population and numbers will give an idea about the status of the habitat.

As a short-term measure, community fencing with solar could be an option. Especially with programs like subsidies, farmers will also be interested to protect their farms and crops.

Enrichment of the habitat and providing water holes can be another option

Though alternate cropping is not preferred by farmers to reduce the crop damages, it is observed that mulberry is a crop grown in these areas are not generally raided Similar crops which are not preferred by elephants for feeding may be planned with the help of Agriculture Department.

Case Study – 2: Location: Ramanagara Division, Channapatna Taluk, Tenginakallu area, Aralalusandra, Menasigana halli.

On 12.02.2018, in the vicinity of the above-mentioned village, the kaccha road connecting Bhoo halli with Menasigana halli, Sri Putte gowda, aged about 52 years has died due to Elephant attack. This person is working as a labourer and falls in the economically poorer section. He was working as a labourer in the farm of Sri

Hanumanthappa of Bhoo halli village of Channapatana Taluk and lived in a hut inside the farm.

As usual in the morning of the day at 5.30 AM, he went to Menasigana halli to fetch milk for his owner and was walking in the kaccha road from Boo Halii. While he was walking near the mango garden belonging to Sri Puttswamy, suddenly an elephant attacked him and due to severe injuries on the body, Sri Puttegowda died on the spot.

Sri Hanumanthappa who was the owner for whom Sri Puttegowda was working was walking in the same road and observed that someone is lying on the road, and when he went and saw that, it was puttegowda who was working as labourer in his farm. After observing the injuries, he found the person is already dead. Nearby he also observed elephant dung and the foot marks. He suspected that the injury and death due to elephant attack and then informed the Forest department officials. Deputy conservator, Assistant Conservator, concerned Range officer all visited the spot and also informed the police personnel and followed due process as required.

The villagers of the adjoining areas gathered and entered into argument with the Forest Department officials about the incident and not able to rein in the wild elephants in the forests. They urged the department to ensure that adequate action be taken to prevent such incidents and also provide compensation for the deceased. The deputy Conservator of forests pacified the villagers that proper action of providing safety for the farmers and other personnel will be taken and that the deceased will be compensated. After post-mortem and completion of other formalities, the body was handed over to the family. The deceased leaves behind wife and four dependent children and he was the lone bread earner for the family.

These incidents highlight the intensity of HEC and also need for reducing the conflict and loss of lives. Creating awareness and also taking adequate precautions goes a long way in preventing loss of lives. When a lone bread earner of the family dies, it leaves the family in a situation from which it will be difficult for them to sustain both

financially and mentally. In such cases, there has to be a long-term support in the form of providing education or a job opportunity for the dependent of the deceased will go a long way in assuring them of their livelihood and sustenance.

Case study–3: Location: Ramanagara Division, Channapatna Taluk, Tenginakallu area, Village B V Halli.

On 27.07.21 Sri. Sathish, aged about 38 years son of Sri Bette Gowda from Doddanahalli village of Channapatna Taluk died due to elephant attack. He hails from the village Doddana halli and was working as a labourer and from an agriculturist back ground. He owns a agriculture land on the fringe of Tenginakallu SF in survey no.30 and was growing Mangoes. As it was monsoon season and the weeds have grown abundantly, he engaged two laborers from Doddanahalli village, Sri.Chandre Gowda and Puneet Kumar to clear the weeds. Around 2.00 pm in the afternoon, there was a lone wild elephant attacked Sri Sathish who was working in the farm from behind which he did not notice nor had time to escape. The other two labourers tried to drive the elephant with the help of surrounding villagers from the adjoining farms and successfully drive away the elephant from the scene. But by then the injuries was severe that Sathish had died on the spot.

The incident has been reported to the Forest officials and the spot was visited by Deputy Conservator, Assistant Conservator, Range Forest officer and examined the incident. In the meantime, the villagers of the surrounding area gathered and the situation became tense and sensitive with arguments and accusations on the Forest Department for not controlling the movement of the elephants. They kept the deceased body there itself and protested against the incident. The Deputy Conservator of Forests eventually convinced the villagers about the efforts made by the department in reducing the conflict and assured them that further precautions and arrangements will be made to reduce the conflict. He also assured them of timely compensation for the deceased family and only after these assurances the villagers allowed due process and formalities to be completed.

The deceased Sri Satish leaves behind his wife and two Yung children and aged mother and ne was the lone bread earner for the family. These incidents leave behind families which are put to great difficulties both mentally and financially. Long term programmes to ensure that the dependents are taken care of besides the ex-gratia amount needs to be looked into.

Case Study – 4: Observation on the effect of Solar Tentacle fence in reducing HEC in Bandipur Tiger Reserve

During the year 2018-19 in Bandipur Tiger Reserve, to reduce the HEC and control the damages to crop and property of the adjoining farms of Bandipur Tiger Reserve, solar tentacle fencing was taken up. Following are the details of the Solar tentacle fencing taken up Range wise.

Sl. No.	Range	Length of Solar Tentacle fence (km)
1	Kundukere	11.20
2	GS Betta	20.50
3	N Begur	5.00
4	Gundre	6.30
5	Moliyur	5.00

The number of cases of conflict and crop damages and compensation paid prior to establishing these Solar tentacle fence and also number of cases and compensation paid after the solar tentacle faces have been compiled from different ranges and the same is presented with a view to assess the effectiveness of the solar tentacle fence in reducing the conflict.

Following table shows the details of number of compensation cases before and after erecting Solar fencing in Bandipur Tiger Reserve.

Sl No.	Range	Length in Km	Cases prior to erection of solar fence		Cases after erection of solar fence	
			Year	Cases	Year	Cases
1	Kundukere	6.0	2016-17 & 2017-18	182	2019-20 & 2019-20	6
2	N Begur	5.0	2016-17 & 2017-18	100	2019-20 & 2020-21	28
3	Gundre	6.30	2016-17 & 2018-19	52	2019-20 & 2020-21	35
4	Moliyur	5.00	2017-18 & 2019-20	27	2020-21	2
5	G S Betta	20.50	2016-17 & 2017-18, 2018-19	500	2019-2 & 2020-21	430
Total				**861**		**501**

It is observed from the above table that with erection of Tentacle solar fencing the number of cases has come down considerable in most of the ranges. Further, it may be planned to have the double tentacle solar fence in areas where there are already gaps as well as fresh areas where it is required depending on the site requirement. This will further reduce the number of cases and conflict.

Already substantial length of barricades of different types have been set up on the boundaries of the Bandipur Tiger Reserve to reduce the conflict. Further, it is observed that the double solar tentacle fencing being very effective in reducing the HEC, a boundary length of 125 km can be taken up with double solar tentacle fencing at a proposed cost of Rs. 5.00 lakh per Km and a total outlay of Rs.625 lakhs is submitted to the Government. This is expected to reduce the conflict considerably and the crop and property damages of the villagers in the surrounding areas.

Case study – 5 : Community solar fencing

In village Thenkala Hundi in Gundlepete Range under Mysuru Division, three farmers Sri Srinivasa Murthy, Koose Gowda and Nataraja came together for their 12 acres of land to have it fenced together. During the years 2019-20 1nd 2020-21, this entire area is fenced with solar fence. Their farms were located about 3.5 km from Beemnabeedu SF.

Prior to erection of solar fence, they were growing maize, groundnut, sunflower and ragi. Their average annual income put together for the entire 12 acres was around Rs.3.0 lakhs. During 2019-20 and 2020-21, all three farmers came together and decided that their 12 acres to be solar fenced. Total length of 2.0 km of solar fence for all the three farms together were erected on one side. One farm had a length of 700 m costing Rs.80,500 after availing subsidy of 50 % from the department. The second farm had a length of 600 m with a cost of Rs.69,000 after subsidy. The third farm had a length of 700 m after incurring an amount of Rs.80,500 after subsidy. Thus, all three farms together an amount of Rs. 2, 30 000 to fence the entire 12 acres after obtaining a subsidy of 50%. After erecting the solar fence as the area was fairly well protected from wild life including elephants, they changed their cropping pattern to grow more of commercial crops such as banana, turmeric and red gram. On the other side, the amount of crop compensation also gets reduced if the area was prone for elephant raids. This has enabled them to get a rise in their annual income to Rs.7.0 lakhs from earlier of Rs.3.0 Lakhs. They attribute this increase in returns to protection of crops from wild animals and thus they are able to grow commercial crops.

Case study-6 : Community Fencing

Three farmers, Veeranna, Gurumallappa and Shanthappa from Bettadamadahalli village in Gundlupete Range under Mysuru Division has come together with an area of 5.24 acres to erect solar fence. They were growing crops such as turmeric, banana, coconut and marigold for flowers. They barricaded to an extent of 1400 m length

after availing subsidy for 1120-meter length. The farmers share amount was to an extent of Rs.1, 28,800 after availing a subsidy of 50 %. Prior to erection of solar fence, they were growing maize, cotton and turmeric and on an average, they used to get returns of Rs. 180,000. After erecting the solar fence in 2020-21, apart from growing Ragi, they are growing beans, Cow pea, turmeric and Banana, Tomato. With the protection from wild animals and also due to change inn the cropping pattern by going for more commercial crops, their average returns from the total area is increased to Ra. 4.50 lakhs. The additional benefit of erecting the solar fence in a community way is likely that the crop compensation may gets reduced if the area is prone for wild like animal damages.

The community solar fencing needs to be encouraged to the extent possible as it would reduce the crop compensation and farmers are also able to get improved returns due to better protection. Also department may explore the possibility of increasing the subsidy to such efforts of community fencing compared to individual fencing by farmers.

Pictures showing the Community solar fencing in Gundlepete Range

Chapter- 5: Summary and Conclusions

The objective of this evaluation study was mainly to examine the various methods used to mitigate the Human Elephant Conflict and its effectiveness on conflict resolution and minimizing. The genesis of the problems of the HEC, and the problem itself is so complicated, effectiveness of the various measures such as barriers used to mitigate the conflict, potential areas of conflict and the degree of severity of conflict varying are some of the aspects examined. During the survey and inspection in the five districts on a sampling basis 10 % of the barriers constructed during the study period and about 854 farmers were visited from 128 villages and data collected as per schedule and analyzed. Along with this additional information was collected from the Department pertaining to various measures taken already and proposed works in this regard is also compiled and analyzed. The results are presented and discussed. The findings have shown various advantages in measures already adopted and also some of the short comings or gaps in implementing and executing the same. In addition, it also enabled further to suggest better measures to manage the HEC. HEC in general has two components one is the preventive or protective measures which is covered by various measures as mentioned above and the other being the effect part. This component of HEC is the damages to crop, property, injuries and death of humans and elephants. ex-gratia payments made to compensate the damages, injuries and human deaths. This has been examined and analyzed through the survey of affected farmers. Based on these findings, suggestions regarding the various short-term measures (use of barriers and other complimentary measures) as well as long term measures have been attempted.

The study area is comprising of five districts which are major elephant habitats in the state, Ramanagara, Mandya, Mysuru, Chamarajanagar and Kodagu. These administrative districts coincide with some forest circles and some of them spill over into two districts. However, all the elephant habitats including the Bandipur NP and Nagarahole NP have been covered. The presentation of the findings is given division wise as some of the districts will have 2-3 forest administrative divisions. Also, NP like Bandipur is spread over two districts of Mysuru and Chamarajanagar, hence presenting the findings and its analysis division wise is a better option.

The evaluation study involves collection of primary data from the field and secondary data from various sources including Karnataka Forest Department. The primary data involves sample checking of the barriers (10 %) of different kinds erected during the period of study. Collection of data from affected farmers due to HEC on crop, property damages in selected sample villages. Their impression and opinions about various measures and relief works extended by the department in addition, the team had group discussions with villagers, gathered information from the field officers, village leaders as per the annexures approved by KEA. These are presented under the results and findings chapter along with discussions.

To begin with after perusing the preliminary data and studying the elephant habitats in the study area, the landscape involved has been categorized into three types, which has been explained in the previous chapter. This categorization has helped in grouping of problems which are similar to the landscape and genesis or reasons for the conflict, various methods employed to mitigate and the results thereof. Further, this has also assisted in suggesting the barricades either single or in combination which are effective in these categories of landscape. This evaluation eventually assists in looking at the gaps and suggestions to overcome these gaps to reduce and manage the conflict, which is the ultimate objective.

5. 1 Study area

The areas taken up for evaluation study has diverse elephant habitats as mentioned in the three categories of landscape which presents a total picture of the elephant habitats in the state. These areas also form a larger elephant population extending to adjoining states of Tamil Nadu and Kerala. The districts of Ramanagara, Mysuru, Mandya and Hunusur has a typical elephant habitat where the forests are fragmented and interspersed with agriculture and human habitation. Such a mosaic pattern has abundant problems with its diffused forest boundaries and somewhat difficult to manage the conflict in these areas. These areas, have high number of crop depredation cases and often they are on the rise. Ex gratia payments is increasing every year. Measures such as barriers employed have often limited success or needs to be taken up in more numbers. Even setting up of physical barriers in such a landscape is not easy and often futile. Overall conflict in these areas is intense and are peculiar in nature. Unless the boundaries are changed from diffused to hard boundaries which is difficult and change in land use, which is also unlikely, protection of crop fields by individual solar fence or community

solar fence is a viable option. The possibility of few farmers whose lands are adjoining can come together and avail the subsidy facility extended by the department to protect these crops and reduce the conflict through solar fence.

In the second category falls areas like Chamarajanagar, Bandipur, and Nagarahole. Here the scenario is different. Elephant habitat varies as the forests are compact and relatively extensive and continuous and interconnecting to other PA's. They have continuous hard boundaries and villages are located on the fringe of the boundaries. Conflict existing here is of different kind and magnitude. The various short-term methods employed in the form of physical barriers have been fairly successful in managing the conflict and it is on a less severe note compared to the first category. Effective physical barriers such as rail fence have longer span and more effective in reducing the conflict. Combination of EPT and Solar fence have also given good results in these areas.

The third category is an interesting one with hilly and undulating terrain and the forests are interspersed with plantations such as coffee, pepper and cardamum. These habitats are seen in Kodagu district. Here the forests are generally on the slopes and then in the valleys agriculture crops like Paddy is grown. Many coffee estates have become home of these elephant populations which have become resident in these areas. Problems here are peculiar as these are heavy rainfall area and measures like EPT and Solar have limited success. But Solar fence has given fairly good results.

These habitats under study have an estimated population of 5740 elephants. Each of these categories have conflicts of different degrees and of different types but the patten of problem is uniform, farmers are affected, heavy amount of compensation is being paid and also increased allocation to setting up of barriers and its maintenance. But each of these sites have some of the measures adopted (including barriers) working satisfactorily and reducing the conflict and bringing it to manageable levels.

The above findings have thrown up some issues of both short term and long-term ones for effective management of HEC. The immediate measures adopted in all the areas is protecting the life and property though physical barriers and then payment of ex gratia. More focus has to be on protective and preventive measures rather than compensating the farmers later. At the same time, long term issues such as managing the elephant corridors, status of its habitats and carrying capacity especially in the fragmented

patches of forests needs to be studied. Whether these areas are able to sustain the population of elephants existing needs to be examined. Estimation of population in these areas and the density will give a picture of the status.

5. 2 Preventive measures

Barriers

One of the effective short-term measures to reduce the conflict is to set up physical barriers. Different types of barriers are in use and have been constructed to manage the conflict in the study area during the period as well as in the earlier period also. To begin with it was EPT with old norms and later improved to make it more effective, Solar fence both ground and tentacle type, and combination of EPT and solar fences were erected. In addition, Rubble stone walls, special structures like RCC pillars were used to supplement the main barriers. Rail fences which have been in use of late has been effective in reducing the conflict. But it has limitations of usage in specific areas and also cost involved.

EPT is an effective deterrent provided it is used in appropriate site and maintained properly. In most of the areas under study EPT has been used and has given mixed results. In places like Bandipur, Mysuru and Nagarahole it has been a good deterrent, The reasons being, the flat terrain and easiness in maintaining and also proper maintenance without the trench being covered by bushes and weeds and accumulation of silt. In areas like Ramanagara, Chamarajanagar and parts of Kodagu, it has not fared well mainly due to lack of maintenance and in some places, it has been abandoned. The main reason being non-maintenance of the trenches which resulted in accumulation of silt, rubbles and weeds and an easy path for elephants to cross over, making the exercise a futile. Funds for maintenance is mandatory for initial few years. As it is observed wherever EPT has been maintained has been functioning satisfactorily. Trenches which have been taken up earlier during the period 2014-15, has not been functioning well mainly due to lack of maintenance. The deterrence abilities of the EPT in plain, flat terrain, is good provided it is maintained. Many times, other wild animals like wild boars and deer will make way for the elephants to cross over. EPT must not be constructed in slope areas as it results in waterlogging in rainy season and accumulation of silt resulting in reduced efficacy and life span. Apart from maintaining, monitoring

these is also required. It may be better to involve communities and form teams to check the status of these barriers at regular intervals for better maintenance and effectiveness. It is observed that in most of the sites where EPT is constructed no allocation of funds is made for maintenance. This will render the barricade ineffective within a year or two. It is essential to maintain the EPT for a minimum period of three years either through an agency or by involving communities on an incentive-based mechanism.

Solar fencing is gaining importance and is popular due to its effectiveness in deterring the elephants and cost effective. Both ground and tentacle type has been taken up in all the study areas. Most of them are functional and well maintained. They need regular maintenance as weeds growing beneath and around the lowest wire come in contact with the wires and will render it ineffective. They need battery at every 3 km of the fence and must be checked for its voltage for better effectiveness. Except in few cases in Ramangara, Chamarajanagar, in most of the other areas it has given good results and working satisfactorily. Some observations made here are, during rainy season in areas like Kodagu due to overcast weather conditions often they are not effective. Hanging solar fences are effective but needs maintenance. In addition, it can be installed where there is no or low canopy. But overall Solar fence has been effective in reducing the conflict with proper maintenance. It is observed that a well-maintained solar fencing of both ground and tentacle type is a good individual barrier which is effective in reducing the conflict amongst the physical barriers

It is also observed that combination of barriers placed strategically is more effective than any single barrier. A combination of Solar and EPT with a gap of one meter proves to be more effective in deterring the elephants from crossing over. Their effective functioning is observed in Mysuru, Bandipur and Nagarahole Divisions. However, it cannot be adopted in all places due to high cost. Only in areas of severe conflict, these can be taken up. It is emphasized that both needs to be maintained, if any of the barrier is not maintained, their combined effectiveness will be reduced. Selection of type of barriers based on site specific requirements is an important aspect to ensure its effective functioning and reducing the conflict. In areas like Ramanagara and parts of Mysuru, Hunusur, solar fencing protecting the farm boundaries is more appropriate than having any kind of barriers all along the diffused forest boundaries which is in anyway untenable. Incentives in the form of subsidies and motivating the farmers to take up

fencing on a community basis with solar fence needs to be looked into. An inbuilt mechanism to maintain the barricades along with construction is probably a better option, if these barriers have to serve the purpose and also have a reasonable life span. It is important to look for failure points or gaps existing while the barrier is erected as it might make it ineffective. This can be effectively done by forming a monitoring team with the adjoining villagers. However, elephants are known to push down these barriers and cross over trenches, change the routes to avoid alarms and cross over along with the herd is a known fact by now

It is suggested that in these elephant habitats, a road map showing the degree of severity of conflicts, extent of barriers planned and type of barriers depending on the site, and monitoring and proposal to cover these areas in a phased manner needs to be drawn up. Apart from these barriers as short-term measures, long term measures as a permanent or semi-permanent to reduce the conflicts needs to be planned.

Rail fence of late has been an effective barrier to reduce the conflict. It is used in Bandipur and Nagarahole Divisions. These sites are suited for construction of rail fence. They have better deterrence abilities and have relatively long-life span. But due to high cost cannot be extensively used. It is also observed that elephants tend to escape through the gaps which are about 3 feet now. With the height at 6 feet some of the elephants have tried to cross over and got struck and some males whose height is more than the height of the fence have crossed the rail fence. In such cases combination of rail fence with Solar may overcome the problem and will also improve its efficacy. There are some suggestions to revise the specifications to avoid elephants escaping through these. But in all these the cost factor needs to be taken into consideration.

Of late in some states, steel wire rope fence of five strands with concrete poles and wooden poles with a height of 2.5 M are being tried. The estimated cost would be 50 - 55 lakhs per km. making this at least 40 % less than rail fence cost. But the effectiveness of this barricade on a large scale needs to be tested.

Details of steel wire rope fence are given in **Annexe-9**

Use of rubble stone walls and RCC pillars are mainly supplementing the other barriers like EPT. Especially it is observed that when EPT is not maintained, often wild boars and other herbivores makes way through the trenches and at the same time elephants

will also use those gaps to cross over. To prevent such gaps effectively, rubble stone walls area used effectively.

Correlating the barricades constructed and the forest boundaries, it is observed in the study area that in forests which are compact and has continuous forest boundary, the barricades set up in those areas and maintained have reduced conflict. In areas like Ramanagara and Mysuru, Hunusur and Mandya the nature of land scape and difficulty in setting up barricades have resulted in a greater number of cases and ex gratia payment. Presence of barricades have brought down the number of cases of conflict compared to areas like Ramanagara, Mysuru and Hunusur where the barricades are less and cases are high in number. This also could be due to the landscape, where setting up of barricades in a diffused boundary is difficult and often unviable.

There is a need for refresher workshop frequently for department officials and communities involved in maintaining the barriers.

Complimentary measures: As mentioned above in a diffused boundary interface, it is challenging to manage the HEC. Apart from various preventive and after effect measures are taken to manage the HEC, some complimentary measures will assist in reducing the conflict. Guarding or night watch of crops, early warning about the impending raids and establishing a network to enable this goes a long way in reducing the damages. Some of these have been adopted by the farmers with the help of Department. But this needs to be more focused and streamlined so that preventive measures can be made effective. To enable this, awareness creation about the stake holders and formation of groups and involving them and providing them facilities to implement the chalked-out program.

It is observed that managing the conflict has to be a multi-pronged approach if it has to sustain and they are not mutually exclusive Preventive and Protective measure along with payment of ex gratia is to be taken as a whole package. Whether erection of barricades or complimentary measures or habitat improvement, restoration of corridors should all go hand in hand depending on the site requirement and the degree of problem of conflict. As a long-term measure, preparing the blue print at state level which includes both short term measures and long-term measures (One of the recommendations) needs to be in place. Simultaneously, Divisions which have been

identified as high and moderate risk areas need to prepare a road map at division level in line with the blue print for the whole state. These division level recommendations will address the site-specific problems and suggest measures for better sustainability. For example, in case of Ramanagara division, as a short-term measure, barricades are not sustainable due to mosaic pattern of land use. For sustainability, a long-term measure has to be devised.

5. 3 Crop raid cases and compensation

Crop Raids

The crop damage cases and ex gratia is mainly seen as an effect of the HEC. The conflict has already damaged and whatever compensation is being made is mainly supportive in nature. As the economic loss and the emotional factor cannot be fully compensated. The number of cases of crop and property damages has been observed and data collected in sample villages. Villages vary in the number of cases as this depends on the proximity of village to the boundary and also nature of crops grown, seasonality, sage of crop and other factors. In a mosaic pattern of landscape where forests, agriculture and habitation occur with a diffused boundary and villages which are not only close to the forests, but even those away at a distance will also bear the brunt of elephant raids. Such cases are more seen in Ramangara and Mysuru, Mandya and Hunusuru. The fragmented patches may not offer much forage and water for the elephants, while the villages outside these areas (both nearer and far away) have plenty to offer. Whereas in compact and continuous forest areas with hard boundaries, villages on the fringe will see more attacks. This could be due to the availability of sufficient forage and water not only in its habitat but also on the fringe villages. Distances may not be the criteria for elephants in search of forage and water if they are not adequately available in their habitat or adjoining villages to the forests. Identifying such areas having repeated attacks and preparing a vulnerability map for the area based on this information will go a long way in taking precautions to minimize the conflicts. It is noticeable that fragmented patches may not provide sufficient forage and water for the population for the elephants in some of the areas in this study and this is further confirmed by the high number of cases occurring in the surrounding villages. It is important that carrying capacity of the elephant habitats are studied and possibility of enriching the habitat in such areas along with providing water holes may minimize the

damages. Mapping of the vulnerable villages and taking site specific precautions and forewarning will help in minimizing the conflict and damages.

Often due to administrative reshuffle as seen in formation of Cauvery wildlife sanctuary the elephants have been frequenting the nearby villages and incidents of crop raids have also increased after 2013-14. Monitoring the interface of the park and villages and efforts to prevent its entry into agriculture areas may be taken up on priority. The probable reasons for some of the villages having a greater number of cases in Ramanagara and Mysuru divisions could be due to the mosaic pattern of forest and villages interspersed and also availability of crops during the dry seasons. In Chamarajanagar, the fringed villages on the boundary appears to have more cases. Some of the reasons for this variation could be fragmented forests interspersed with villages and habitation, proximity of villages to the forests, cropping pattern and seasonality, type of crops the farmers grow and the measures adopted to reduce HEC.

Elephants generally raid crops after dark. They are known to feed throughout the afternoon and peak at evenings and night times and often do till early morning hours. They prefer dark and avoid human contact. Based on the data collected, most of the cases of crop attack has taken place in the night. Taking adequate precautions like night watching and communication network for early warning and forming squads or groups to drive the elephants and providing all necessary equipment to the groups is necessary. This time of night is also vulnerable time for farmers as they go to their farms either for night guarding or to switch on their irrigation pump sets and that is when they accidentally encounter elephants and gets injured or death occurs. In areas where there is problem with power supply during day times, Department of power may be requested to provide power during day times for designated hours to such of those villages which are identified as more prone for raids so that farmers can operate the irrigation pumps during day time. In addition, providing street lights in the village through solar power will help the villagers to avoid the conflict and make them more secure.

Crop raiding involves not only damage due to feeding on the crops but also due to its movement and trampling in the area. The entire area is subjected to depredation rendering the surrounding area unfit for any use. The large ranging pattern of the elephants makes the damages an intense one resulting in farmers not only put to

economic loss but also under considerable mental agony and anxiety. It also affects the socio-economic security of the farmers resulting in challenges of the conservation aspect.

It is observed across all divisions in the study area, almost 46 % is in the category of area damaged being more than one acre. Generally small and marginal farmers tend to go for field crops like Ragi, Maize, Jowar, pulses and paddy. Medium and large-scale farmers have larger holdings and go for commercial crops like Banana, mango, coconut and in Kodagu mostly Coffee, pepper and cardamum along with paddy and banana. In Mysuru, Madikeri and Virajpete with more of commercial crops the percentage of area damage is higher than one acre. This indicates some correlation between commercial crops and the extent of damage by elephant raids.

There is preference for elephants raiding the crops at mature stage. Data shows that in Ramanagara almost 95 % of the raided cases are when they are in mature stage. Similar trend is seen both Mysuru and Chamarajanagar. Correlating the data on seasonality of raids and the stage of crop indicates that that the peak raid percentage coincides with the maturity stage of the crop. Seasonal food crops reach harvesting stage during these seasons. That major portion of the raids takes place during the months of October to March, these months are the post monsoon months and also drier months. This period also coincides with the near harvesting and harvesting stages of the crop. The key indicators for mitigating the crop raids are the seasons and the stage of the crop when measures are to be initiated. Engaging more man power and a coordinated network of early warning system and driving the elephants can minimize the damages.

The study area has been categorized into three classes depending on the risk level which is based on the number of crop raid cases and ex gratia amount paid. Further based on the classification of landscape categories, the first category where the forests and agriculture and habitation are distributed in a mosaic pattern, divisions like Ramanagara, Hunusur, Mandya and Mysuru falls in this and the level of risk ranges from Low (Hunusur) to high (Ramanagara) and being moderate in Mysuru. In these areas it is EPT and solar fence barricades have been effective in deterring and reducing the conflict. The combination of these two have been more effective in reducing the conflict. But in large tracts of farm lands, solar fencing by farmers either with subsidy

by the department or on their own appears to be popular in reducing the conflict. The solar fence and the combination of EPT and solar are cost effective measures in these areas.

In districts like Chamarajanagar, and divisions like Bandipur and Nagarahole where the boundaries are continuous and hard which falls in the second category of landscape classification, have risk categories between moderate and high. In these flat and plain areas, EPT is still popular and has good functional abilities. In additions solar fence has given good deterrent abilities. Combination of EPT and solar has been very effective in reducing the conflict. With rail fence being adopted as one of the barricades of late, it has been quite effective in managing the conflict. Though Rail fence is effective, it is the cost consideration which comes in the way of adopting on a large scale. However, in these areas solar fence and combination of solar and EPT have been cost effective and being adopted in large scale.

In hilly and undulating areas like Madikeri and Virajpete, which falls in the landscape category of hilly and undulating areas with forests and plantation crops such as coffee, the risk levels have been ranging from moderate to high. In these areas, solar fence has been effective compared to EPT and combination of Solar and EPT are good in these areas. These are the cost-effective barricades in these areas.

Ex-gratia

Crop compensation due to damage by elephants is an important but often less understood and an underestimated problem. Compensation in some form is very essential in areas where the problem is severe and also necessary to avoid resentment of the affected farmers. The affected person will tend to seek immediate compensation for his loss. Apart from the economic loss this is a sensitive issue as many times the livelihood is at stake and at times the bread winner for the family is killed and a bleak future looms large for the family. Payment of ex gratia is mostly addressing the effects rather than the cause. Quite often, the affected person will not be satisfied with the compensation measures. Delayed payment and inadequate amount not commensurate with the loss are the other issues.

Data from the study areas shows that in most of the divisions the farmers have received

payment exceeding Rs.3000. indicating the intensity of damage to the crops. The extent of damage is severe in some places and comparatively mild in other places. Farmers adjoining Nagarahole NP has received maximum after Hunusur which has 100 % of the farmers receiving ex gratia of Rs.3000 and above.

In most of the cases farmers perceive that the damages and loss is much more than what is assessed and ex gratia paid. In most of the cases it is the marginal farmers who are affected badly as they practice subsistence agriculture for their livelihood and they also happen to get the least ex gratia amount due to the nature of crops grown. This not only creates disparity amongst the farmers but also difficult to address. In many places, other option such as compensating the affected farmers with food grains to ensure food security is being taken up. One such program of grain for grain is initiated by a foundation in Kodagu.

Death of an individual due to HEC is a major setback for the family especially if he is a lone earning member. In such cases, family and children are most affected. Monitoring such cases and providing guidance and support to the children is an essential part of the support system.

The other problems associated with the ex-gratia payment is the timely payment and the adequacy of the amount. More often in many cases the amount is not received on time (within a reasonable time of three months) and also farmers express that it is not adequate. It is difficult to compensate the actuals considering that the ex-gratia is a supporting activity and also the rise in cases and the amount involved. However, the rates of compensation need to be revised periodically considering the stages of the crop damaged. There is a need for a fast-track disbursement. One suggestion is to allocate a corpus fund for divisions which have huge ex gratia payment and as and when it gets exhausted keep replenishing it in a revolve fund system. However, this has been addressed by the department through e – Parihar and also setting aside funds for ex gratia payment outside the purview of the plan funds making it easier for disbursement.

Based on the number of cases and the amount of ex gratia paid, assessment of severity of HEC shows that villages around Ramanagara, Virajpete, Bandipur have been categorized as High-risk areas. Mysuru division though the cases numbering high, the amount of compensation is relatively low and has been categorized as moderate. Both

Hunusur and Mandya with low number of cases and compensation amount have been categorized as low risk areas.

5.4 Villagers' suggestions & opinions

The ancillary data collected from the affected farmers gives an insight to their thinking and their initiatives about managing the HEC and the extent of assistance by Department.

Most of them opined that barricade has reduced the conflict and they need more barricades. But the constructed ones are to be maintained for effective functioning. Most of them feel EPT and Solar fence combination is effective, Rail fence being the best. Many farmers have taken the initiative of barricading their farms with solar fence either on their own or through the subsidy facilities offered by the Department. Villagers feel that often due to either lack of maintenance or not having a continuous barricade in the interface area elephants cross over to their fields. There is a need to attend the gaps in the boundary without barricades.

Forewarning mechanism is important in preventing the damages, it is observed that many villagers are not interested in involving themselves in activities to reduce the conflict. Educating and creating awareness about the preventive steps and incentive-based approach might be successful. These programs should be an integral part of HEC programs as much as ex gratia payments. Establishing a network communication through 'WhatsApp' or any other mode for early warning is necessary.

Villagers' involvement will be better if they are provided with facilities such as setting up watch tower in crucial areas, sensor mechanism to forewarn entry of elephants and providing them with drums, crackers, torch lights. Organizing training mechanism in maintaining the barricades, and many felt that the staff attending to HEC are inadequate.

Regarding ex gratia farmers feel that the assessment is not realistic and does not cover the actual losses and needs revision of the rates. in addition, there is delay in payment. These needs to be addressed by the department and suggestions on these have already been made.

5.5 Forest Department field personnel suggestions

The Department officials, Forest guards, Deputy RFO's and RFO's at field level

handling HEC observed that the elephant movement is mainly in summer and when they are stressed for want of food and water and foray into crop fields. Movement is in regular routes but they tend to stray and change routes where barricades have been set up making it difficult to trace and monitor.

They opined that there is a need for studies on the carrying capacity of different habitats and population in coffee estates.

Rail fence is one of the best physical barriers to deter the elephants from raids. Solar and EPT combination has given good results. The expressed problem of inadequate funds or no maintenance funds for maintenance. Suggestion that in-built mechanism of maintenance for a minimum period of three tears after construction. There is a suggestion to revise the height and gap of the rail fence as it has been observed in many cases, elephants are escaping through the gaps in the middle as well as some of those males whose height is more than the height of rail fence. Formation of full fledge Anti Depredation Squad (ADS) in all areas of HEC. Equipping these ADS is very essential.

The ex-gratia payment needs to be streamlined by setting up a special fund so that there is no delay in disbursement of ex gratia. At present the delay is mainly due to non-receipt of funds in time. It is already suggested to have a corpus fund which can be rotated to avoid any delay.

Data available on projection of physical and financial outlay for further years shows that some of the divisions like Madikeri territorial and Wildlife divisions both have increased projection of financial requirements in the coming years, indicating need for more barricades and probable increased level of conflict. Madikeri Division has projected considerable increase in their projection from 32.9 lakhs to 3399 lakhs and so also the physical targets projected. Bandipur and Nagarahole also have projected increased financial outlay and the physical targets projected in the coming years. These outlays indicate that barricades are being taken up in a phased manner to cover the boundaries.

Chapter – 6 : Recommendations

6.1 Long term Measures

1. Preparing a Blue print or road map of the elephant habitats, with details of the present status, estimating the numbers, carrying capacity of each habitat, conflict zones based on the severity, measures both short term and long term already in place and proposed.
2. Mapping vulnerability zones of HEC and measures thereof
3. There is a need for a well-planned long-term strategy to find a solution to the problem of HEC
4. Considering the possibility of land use change in areas surrounding severe HEC with the active involvement of Department of Agriculture
5. Strengthening of elephant corridors as long-term measure needs to be looked into in these areas
6. Setting up a corpus fund or suspense account for payment of ex gratia to overcome any delay in payments. This has already been addressed by the Department, only to ensure that the system continues without break.
7. Formation of a committee for assessing the crop damage comprising of Agriculture, Horticulture and Veterinary, to assess nearer to actuals
8. Possibility of Crop insurance for wildlife conflicts including elephant. Though at present the provisions are not very convenient for inclusion of HEC cases, this needs to be looked into to develop a system for insurance against wildlife damages in general.

6.2 Short term measures

1. Taking the road map as a guide, construction of barriers in the conflict zones to be taken up in phased manner based on site specificity and requirement. This has to be a planned program covering the length of the boundary in a phased manner so that the deterrence is effective.

2. Forest Divisions having elephant habitats should map the vulnerable ranges and map the risk zones based on the data of crop damage cases and give priority for various measures to reduce the conflicts.
3. Based on the study undertaken, and the classification of landscape categories, the first category where the forests, agriculture and habitation are in a mosaic pattern, in divisions like Ramanagara, Hunusur, Mandya and Mysuru. The risk level ranges from Low (Hunusur) to high (Ramanagara) and moderate in Mysuru. In these areas EPT and solar fence barricades have been effective in deterring and reducing the conflict. The combination of these two have been more effective in reducing the conflict. But in large tracts of farm lands, solar fencing by farmers either individually or community fencing with subsidy by the department or on their own appears to be popular and cost effective in reducing the conflict.
4. Districts like Chamarajanagar, and divisions like Bandipur and Nagarahole which falls in the second category of landscape and has risk categories between moderate and high. In these flat and plain areas, EPT and solar fence individually and in combination has given good deterrent abilities. Of late, rail fence has been quite effective in managing the conflict.
5. Hilly and undulating areas like Madikeri and Virajpete, the risk levels have been ranging from moderate to high. In these areas, solar fence has been effective compared to EPT. Combination of Solar and EPT proved to be effective both in terms of cost and deterrent abilities.
6. Adequate precautions such as providing appropriate barricades and early warning systems and protective measures in high and moderate risk areas (as classified) will reduce the conflict.
7. EPT is an effective site-specific barrier and needs to be maintained properly. As observed, EPT's in Plain and flat terrain which are well maintained are good deterrent barricades.
8. Solar fence has been an effective barrier and needs regular maintenance which will improve the efficacy and also life span. Solar fence both ground and tentacle have good deterrent abilities.

9. Among the combination of barricades, EPT and Solar fencing proved effective than single barricades as a site-specific barrier and only consideration is the cost and its maintenance.
10. Rail fence is a good barricade but the technicalities of sizes need to be re looked Combination of rail fence and solar fence is very effective and will overcome the limitations of rail fence.
11. Steel wire or rope with concrete pillars are being taken up as an alternative to Rail fence. This will reduce the cost considerably. This can be taken up singly or in combination with solar fence. With the projected cost at Rs.50-55 lakhs per km, this works out almost 40 % less than rail fence but the effectiveness has to be assessed on large scale and the trials are on in some areas.
12. Priority to be given to revive those EPT's and Solar fence which have been not maintained or abandoned to put them back in action before taking up new EPT and Solar fence in each division. Ensure the gaps in barricades are closed if any, however, this is being addressed
13. Ensure proper monitoring of the status and condition of barricades by evolving a system where in teams are formed to check the status of barricades to facilitate better maintenance and effectiveness. Team of personnel involving both community and forest can be allotted specific length of these barricades in each division for monitoring and maintenance to make it effective.
14. With the months between October, January and March recording high number of crop raid cases in most of the area, these are the months during which all precautionary measures need to be taken. Having early warning system in place, squads to drive away the elephants, forming groups including youths and facilitating them with equipment to drive the elephants should be kept ready for these months.
15. As a part of the Community based initiatives, exploring the possibility of erecting community solar fencing for farms together is better option than individual solar fencing. This has been observed in Gundlupete Range in Mysuru Division.
16. The subsidy for solar fencing by farmers is being sanctioned if their farms are located within 5 km from the forest boundary, as elephants are known to raid

crops beyond 5 km, extending it up to 10 km from forest boundary will cover those farms suffered.

17. Ensure involvement of community at every stage as they are also the stake holders. Starting from identifying areas of conflict, selection of sites and type of barricades to be erected and its maintenance on an incentive-based mechanism.
18. An inbuilt arrangement for construction and maintenance of these barriers for minimum of three years has to provided.
19. Formation of a dedicated team to monitor and forewarn the attacks and also driving the elephants. This can be a part of the Anti-Depredation Squads or a separate team involving local communities can be formed.
20. The team should be trained in awareness campaign about the conflict mitigation and communication network and forewarning.
21. Plan a landscape-based measures both as a short and long term to reduce the conflicts in areas of fragmented forests interspersed with agriculture and habitation as observed and suggested in Ramanagara division.
22. As a measure to manage the habitat, enrichment of habitat and providing water holes and solar powered bore wells. Some of these activities are already in place, monitoring their functioning and performance and improvement if necessary. The approach has to be multi-pronged with habitat improvement, restoration of corridors wherever possible and also erecting the barricades and expedition of ex gratia payments, all these measures will help in managing the conflict.
23. There is a need to study in detail the carrying capacity of various major elephant habitats to ascertain the status of the habitat and then plan for enrichment or improvement.
24. Community involvement as a stake holder and participate in mitigation measures especially with the knowledge of the surrounding landscape. This will be helpful as Department is always under pressure for lack of manpower
25. Explore the possibility of adopting forewarning systems like the AI system developed by WildEyes to detect and forewarn presence of elephants in the area.
26. Cases where the farmers or villagers have lost the lone bread winner due to HEC, special provisions for providing livelihood and education for the children depending on the conditions needs to be considered.

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Annexe-1
Checklist for Inspection of Barricades

1.	Name of the District	
2.	Name of the Circle and Range	
3.	Name of the Village	
4.	Coordinates at the checking point	
5.	Type of the barricade (if, combination please tick accordingly)	EPT/Solar / Rubble Stone / Rail Fence
5a.	Length of barricade – type-wise	
6.	Length of overlap, when combined	
7.	Whether individual or combination	
8.	Boundary length covered by barricades	
9.	Year of Construction	
10.	Cost of construction	
11.	Maintenance contract period if any,	
12.	Current condition of the barricade	
13.	Current status of the barricade	Maintained / not maintained / damaged / abandoned
	If not maintained, reasons for non-maintenance	
	If damaged and not repaired, reason for not repairing	
14.	Expected life of barricade	
15.	Assessment on quality of work	
16.	Deterrence abilities	Good/Satisfactory/Not satisfactory

Annexe-2

Evaluation of Human Elephant Conflict

Survey instrument for victims/affected persons

1.	Name of the Respondent / person affected	:	
2.	Age & Gender	:	
3.	Address	:	
3a	Distance from the Barricade	:	
3b	Type of Barricade	:	
3c	When the barricade constructed	:	
3d	Distance from the Forest Border	:	
3e	Distance from water bodies	:	
4.	Village	:	
5.	Taluk	:	
6.	District	:	
7.	Forest Range	:	
8.	Contact Number (if any)	:	
9.	Details of incidents	:	

	Particulars	Crop raid	Property damage	Injuries	Death
9.1	Exact Location				
9.2	Date				
9.3	Time				

10.	Details of incidents		:	
10.1	**Crop raids**		:	
	10.1.1	Area of crop raided (acres)	:	
	10.1.2	Nature of crop – Ragi, paddy, maize / sugarcane / commercial crop	:	
	10.1.3	Months of peak crop raids	:	

	10.1.4	Stage of crop	:	Seedling/maturity/ harvesting
	10.1.5	What are the crops raided most	:	
	10.1.6	Extent of damage – Total or Partial	:	90-100%/ 50-90%/ less than 50 %
	10.1.7	Estimated value of loss (Rs.)	:	
	10.1.8	Ex gratia paid	:	
	10.1.9	Whether ex gratia received in full or in instalments	:	
	10.1.10	Whether ex gratia received on time	:	
	10.1.11	If not, in how may days	:	
	10.1.12	Whether ex gratia paid is adequate or not, if not why	:	
10.2	**Property damages**		:	
	10.2.1	Type of property damaged	:	
	10.2.2	Estimated value of damage	:	
	10.2.3	Ex-gratia paid	:	
	10.2.4	Whether ex gratia received in full or in instalments		
	10.2.5	Whether ex gratia received on time		
	10.2.6	If not, in how may days		
	10.2.7	Whether ex gratia paid is adequate or not, if not why		
10.3	**Injuries**			
	10.3.1	Name of the person injured	:	
	10.3.2	Age & Gender	:	
	10.3.3	Relation to the respondent	:	
	10.3.4	Type of injury &Magnitude	:	
	10.3.5	Medical Cost incurred	:	
	10.3.6	Ex gratia paid	:	
	10.3.7	Whether ex gratia received in full or in instalments	:	
	10.3.8	Whether ex gratia received on time	:	
	10.3.9	If not, in how may days	:	
	10.3.10	Whether ex gratia paid is adequate or not, if not why	:	

10.4	**Deaths**			
	10.4.1	Name of the person deceased	:	
	10.4.2	Age & Gender	:	
	10.4.3	Relationship to the respondent	:	
	10.4.4	Occupation of the deceased	:	
	10.4.5	Ex gratia paid	:	
	10.4.6	Whether ex gratia received in full or in instalments	:	
	10.4.7	Whether ex gratia received on time	:	
	10.4.8	If not, in how may days	:	
	10.4.9	Whether ex gratia paid is adequate or not, if not why	:	
10.5	Efforts made to counter the raids from respondent side		:	
	10.5.1	Whether farmers taken any precautions like crop guarding?	:	
	10.5.2	IT help/App etc., (individual / group/corporate effort)	:	
	10.5.3	Has he sought help of other farmers	:	
10.6	**Support from Forest Department**		:	
	10.6.1	Whether support from Forest Department is adequate or not	:	
	10.6.2	If not, what is expected	:	
	10.6.3	Whether Department created awareness / consulted before construction of barricades	:	Yes / No
	10.6.4	Any training / capacity building on maintenance of barricades (with details)	:	Yes / No
	10.6.5	Any communication network to forewarn about raids	:	Yes / No
10.7	**Support from District Administration**			
	10.7.1	Whether support from District Administration is received or not	:	
	10.7.2	If not, what type of support is expected	:	
10.8	**Support from any Society / NGO**		:	
	10.8.1	Whether received support from Public	:	

	10.8.2	If yes, what type of support	:	
	10.8.3	If not, what type of support was expected	:	
	10.8.4	Is he willing to volunteer to assist the Dept. in their measures to reduce the conflict?	:	
10.9	Type of barrier used near the respondent area (single or combination)		:	EPT / Solar / Rubble Stone / Rail Fence
10.10	Whether it was effective or elephants crossed them easily		:	
10.11	Status of barriers – Functional, Damaged, Repaired		:	
10.12	Possible reason (s) for raids		:	
10.13	Whether the raids were reduced after adoption of mitigation measures when compared to earlier years ?		:	
10.1.4	What more mitigation measures required		:	
10.15	Social benefit from the mitigation measures		:	Feel safe and secured / crop is protected / no worry of family safety / improvement in life style / better health condition / harmony amongst community.
10.16	Any other comments / issues		:	

(Signature of Investigator)

Place :
Date :

Annexe-3

Interview Schedule for members of the society/village

Sl.	Questions / Issue	Remarks / Views
1.	Whether the village is a new settlement or old one	
2.	Which of the crops are mostly raided by elephants?	
3.	Damaging of trees like coconut and mango are they incidental or targeted	
4.	Whether the conflicts existed earlier also or recent times?	
5.	What is the severity of the conflict ?	
6.	Is the severity associated with any changes in landscape or any new developments in the area?	
7.	How often deaths occur, is it incidental?	
8.	Does villagers take any precaution on their own to protect crop and property	
9.	How soon the Department comes to their help after the raid takes place	
10.	Do they have forewarning mechanism to alarm the villagers in the form of network	
11.	Whether the barricades erected has helped in reducing the damages to crops	
12.	Whether the department has discussed with them before erecting the barrier and taken their ideas/opinion/suggestions	
13.	Whether they are joining hands with the department in monitoring and maintaining the barricades	
14.	Whether the Department has approached them to assist them in maintaining the barricades	
15.	Whether they have volunteered to help the department and involve themselves right from the beginning.	
16.	Whether they understand they are also stakeholders in the HEC issues? If not, whether Department has made them understand?	

Sl.	Questions / Issue	Remarks / Views
17.	What is their expectations from Government in reducing the HEC issues?	
18.	If a team is formed by the department with the volunteers whether the villagers are interested in assisting the department to tackle the problem	
19.	*Whether the villagers will take the initiative to assist the department in maintaining the barriers	
20.	Are they willing to have a buffer crop to prevent the elephants from damaging the main crops?	
21.	Have they tried any methods or taken any measures to mitigate the conflicts?	

Annexe-4 (1)

Interview with different level officers in Karnataka Forest Department Level–I (Additional Principal Chief Conservator of Forests, Principal ChiefConservator of Forests)

Sl.	Questions / Issue	Remarks / Views
1	Understanding the elephant behaviour whether they are raiding crops out of necessity or for foraging?	
2	Whether the above factor is taken into consideration while deciding the type of barrier to be erected? What is the basis on which type of barriers are decided	
3	Apart from direct damages to crop and property, has there been any effort to address the indirect losses such as psycho social factors-loss of health, loss of productivity of farmers, aggravating of poverty from socio economic angle by Government?	
4	Any Research and studies on elephant behaviour in the state	
5	Any studies on home range of these elephants in the districts	
6	Any state wise map to be prepared for hot spots of conflicts to address the issue in a focused manner	
7	Whether elephant's movements in its Home ranges and seasonal ranges and regular routes of migration within the state and between the adjoining states have been made and mapped?	
8	As Farmers and Villagers are also the important stake holders is there any long- term program to ensure their involvement at every stage and capacity building.	
9	Involve them for planning level of deciding the barriers to rates of compensation?	
10	Studies related to habitat management of Elephant areas	
11	Whether adequate funds are provided in annual budget allocation for HEC	
12	Is there a possibility of having special status for HEC and provide a revolving fund to expedite timely payment of ex gratia	

Annexe-4(2)

Level–II (Deputy Conservator of Forests, Conservator of Forests and Chief conservator of Forests)

Sl.No	Questions / Issue	Remarks / Views
1	Any identified elephant corridors in the division	
2	If so, what is the status of the same	
3	Whether department has identified hot spots which are high risk areas for conflicts	
4	What is the status of elephant habitat? Do they have adequate food and water throughout the year?	
5	Any developmental activities such as irrigation channels, construction of highways, railway lines, and pipelines have been the reason for increased conflicts? If so, how?	
6	Whether there has been any study on the carrying capacity of elephant habitats	
7	Whether any efforts to identify raiding and non-raiding herds?	
8	Whether Department has ensured the involvement of villagers as they are the stakeholders in the HEC issues.	
9	Whether the farmers and villagers are made to understand and trained the need and maintenance of the barriers by Government through a systematic program	
10	Whether the farmers/villagers are cooperating and are interested in monitoring and maintenance of barriers	
11	Details of Compensation paid during the period of study	

Annexe-4(3)

Level - III (Range Forest Officers, Assistant Conservator of Forests)

Sl.	**Questions / Issue**	**Remarks / Views**
1	What is the status of forests in the area are they contiguous or fragmented?	
2	If fragmented, are they connected?	
3	Whether the status has been similar prior to 2014-15 or was different	
4	Extent of forest boundaries interfacing with villages	
5	Whether these boundaries are continuous or discontinuous	
6	Is the movement of elephants being regular and the routes have been identified?	
7	Distance of the villages from the forests, is it close or far away	
8	Elephant movement during summer- is it the regular route or they likely to stray depending on availability of food and water	
9	Is the ex-gratia paid in full in one go or in instalments	
10	Is there any delay in payment of ex gratia, if so why?	
11	Time lapse between incidence and ex gratia payment in case of crop damages, injuries, and deaths	

Annexe-5

Interview Schedule for FGD with Villagers and Knowledgeable members

Sl.	Questions / Issue	Remarks / Views
1	Is there any other best practices employed to reduce the mitigation either in other states within the country or outside the country asper the knowledge and experience of members?	
2	Is there any specific studies made on the straying behaviour of elephants as per the knowledge of members and any suggestions thereof?	
3	Any suggestions regarding the crops and cropping practices as per the knowledge of members	
4	Is there any improved measures either in terms of barriers or combinations of barriers or in the experience of members?	
5	Is there any other complimentary measures as short term to reduce the damages?	
6	Is there any long term measures such as identifying the problematic herds and trans locating them as per their knowledge?	
7	Any other local practices either to prevent the crop damages and treating of injured persons	
8	Extent of community participation in HEC	
9	Farmers are they willing to maintain the barriers if they are Trained	
10	Whether they are willing to form groups from the villages and form squads	

Annexe-6

Interview Schedule for IDR with District level officers / State Level Officers

Sl.	Questions / Issue	Remarks / Views
1	Any suggestion regarding changes in the cropping pattern or crops which are not attractive for depredation – Agriculture Department	
2	Whether Department of Agriculture through their extension wing can create awareness about the crops and cropping pattern in Elephant areas – Agriculture Department	
3	Whether Agriculture Department can help in realistic compensation for crops damaged by elephants – Agriculture Department	
4	Any studies made by Veterinary doctors as to the behaviour of elephants – Veterinary Department	
5	Are they aware of any techniques of driving the elephants other than what is in practice?	
6	To what extent they are trained and capable of handling of tranquilising the elephants and the process of translocation. – Veterinary Department	
7	Role of police personnel in controlling the mobs when human death occurs due to elephants and that of elephants	
8	While laying out roads whether PWD, road highways considers the movement and corridors of elephants	
9	While laying down the Railway lines, whether the Department takes in to account the movement of elephants and corridors	
10	Most of the human deaths are incidental and happening either in the night or early mornings, the power supply for irrigating crops is given manly during night times when these incidences occurs, is there a possibility of identifying such elephant problem areas and provide power supply for irrigation during day times for few hours rather than night times - Power supply department	

Sl.	Questions / Issue	Remarks / Views
	State level	
11	Whether interaction and coordination with related Departments such as Agriculture,, Veterinary, Roads, Railways takes place before any developmental activities concerning these Departments takes place in Elephant areas	
12	Any constraints in Budget allocation for the elephant problems? Can it be treated as a special case and a revolving fund can be set aside for compensation	

Annexe-7

Pilot Study and Observations

The Study team lead by the Principal Investigator made a Pilot Study visiting Ramanagara and Mandya, the two districts among the five districts identified for the Study. Following are the observations made during Pilot Study which will be considered suitably at the stage of detailed field study / preparation of Report :

1. Districts of Ramangara and Mandya are adjoining and some of their territorial forest areas adjoin that of Cauvery Wildlife area which partly comprises of earlier Ramanagara forest area. In Ramnagara area especially in Channapatna Taulk, it is typically mosaic of forest patches with agriculture area and tanks with cropping season extending to summer. This is one of the reasons for the conflicts with elephant's movement from Nandigundi SF to Tenginakal Gudda SF. With crops such as paddy, Ragi, vegetables, Coconut and Mango with plenty of water has been an attraction to these herds which keep moving from the above-mentioned SF.
2. The most problematic area in the district is Kanakapura Taluk (High priority area) and areas around Channapatna. With location of Cauvery WLS in the south and East of the area, migratory route is more towards Channapatna and Kanakapura. Cauvery WLS has a state boundary with Tamil Nadu area of Denkanikota on the east and on the south of Cauvery WLS it is Chamarajnagar forest area. The spill out of the elephants is mainly from Cauvery WLS and from the adjoining state of TN areas of Denkanikota and Hosur of Krishnagiri District.
3. Only some percent of the elephants out of the total population in the district repeatedly straying into the crop area and also in the same locations indicating that this has been the migratory route of the elephants before the forest patches in the form of hillocks were connected with vegetation in the form of Gomal lands. The problems aggravated after these forest patches were interspersed with agriculture and habitation.

4. Generally, crop raids are on the increase from the month of November onwards and will go on during summer. Earlier (2014-15) Magadi range had the maximum number of damage cases with 954 and subsequently it came down due to erection of Rail barricades in BNP. Subsequently Sathanur and Channapatna (2017-18) had more damage cases and compensation paid and the trend continued even in 2018-19 also. Though some EPT's and solar fencing have been erected in the year 2014-15 and then in 2016-17, the maintenance has not been there for non-receipt of maintenance funds. However, it is observed that EPT with solar fencing appears to have reduced the raids to some extent in the year they were erected unless they are maintained subsequently. Wherever Rail barricades are made it appears to be the best barricade, but cost will always be a consideration.
5. In Mandya district also most of the area comes under Cauvery Wildlife. It is observed that the movement few elephants has been to an extent of 200 km recently (though rare) from Nugu- Arabithittu – KR Nagara- KR pet – Pandavapura – Kardeba – Mandya city. The cropping pattern of sugarcane, paddy and banana and availability of plenty of water has attracted the movement. November to January are the peak months of raids. Most affected is the Malavalli taluk. In this rae earlier during the period of 2000-01 to 2010 -11, about 19.92 km of EPT in seven locations have been made. Some of the reasons for mitigation have been, increase in elephant population, fragmentation of habitats, developmental activities like establishing resorts. In addition, irrigated and commercial crop cultivation has been an attraction.

Other Observations :

6. Crop raids are on the increase from November onwards and will go on during summer.

7. During 2014-15 Magadi range had the maximum number of crop damages and with 954 and subsequently it came down due to erection of Rail barricades in BNP.

8. Subsequently Sathanur and Channapatna areas during 2017-18 had more cases and compensation paid and the trend continued even in 2018-19, indicating new areas of HEC in the district

9. EPT's and solar fencing have been erected in the year 2014-15 and then in 2016-17, but the maintenance has not been there after that either for non-receipt of maintenance funds or lack of manpower.

10. Elephants have the habit of filling partially the trenches and able to cross over and the non-maintenance has made this not very successful deterrent in the area.

11. However, EPT with solar fencing appears to have reduced the number of raids to in the year of construction and subsequently not very deterrent

12. Rail barricades appears to be the best barricade but will be very expensive.

13. Can rail barricades with other barricades be an alternative.

14. Staff movement during raids is difficult due to less availability of vehicles and inadequate manpower.

15. Possibility of engaging local youths from villages to make squads to forewarn and drive elephants.

16. Not any single approach may be sufficient, an integrated approach may be better to reduce the mitigation.

17. EPT and Rubble stone walls made by Cauvery Wildlife area near Shimsha has been effective in preventing elephants to cross over.

Issues arising out of the pilot study :

1. Whether elephant damaged areas can be treated as special areas and thus provide crop and property damage compensation on priority basis

2. Review the crop damage rates in a realistic manner–especially for grown up trees like coconut and Mango

3. Property damage compensation for materials like cart.

4. Need to provide power for irrigation during daytime for few hours rather than in the night as the problem of conflict is more during night times when elephants move and human deaths and injuries are incidental then.

5. Is there a possibility of change in the cropping pattern with subsidy? crops like Mulberry, Sunflower and lime are not damaged by elephants

6. Need better coordination between territorial and Wildlife

7. Often delay in crop compensation given to the farmers – whether it is due to non-receipt of funds in time or not received at all or received and not disbursed

8. Present compensation for damage to crops/property needs to be reviewed and when was it reviewed last time ? Inclusion of more commercial crops by bunching them.

9. Involvement of stake holders in maintaining the barricades and capacity building in this regard

Overall perspective :

1. In the area of Channapatna and Kanakapura the HEC has increased over the last five years.

2. Change in the cropping pattern and availability of water has attracted the elephants from November onwards.

3. The EPT and the solar fencing done in the past does not seem to have yielded desired results due to work in small patches and lack of maintenance and receipt of maintenance funds.

4. May be combination of barricades such as EPT and Solar fencing may be effective for an year or so and needs to be maintained properly.

5. Is there a possibility of connecting the fragmented patches of forests ?

Based on the pilot study, questionnaires have been refined/ revised.

Annexe-8

List of Field crops (Non-Commercial and Commercial Crops) grown in the Five districts

Non-Commercial

- Ragi
- Paddy
- Maize
- Jowar
- Horse gram
- Red gram
- Elephant grass

Commercial Crops

- Banana
- Coconut
- Mango
- Papaya
- Coffee
- Pepper
- Arecanut
- Jackfruit
- Vegetables like Tomato
- Mulberry

Annexe-9

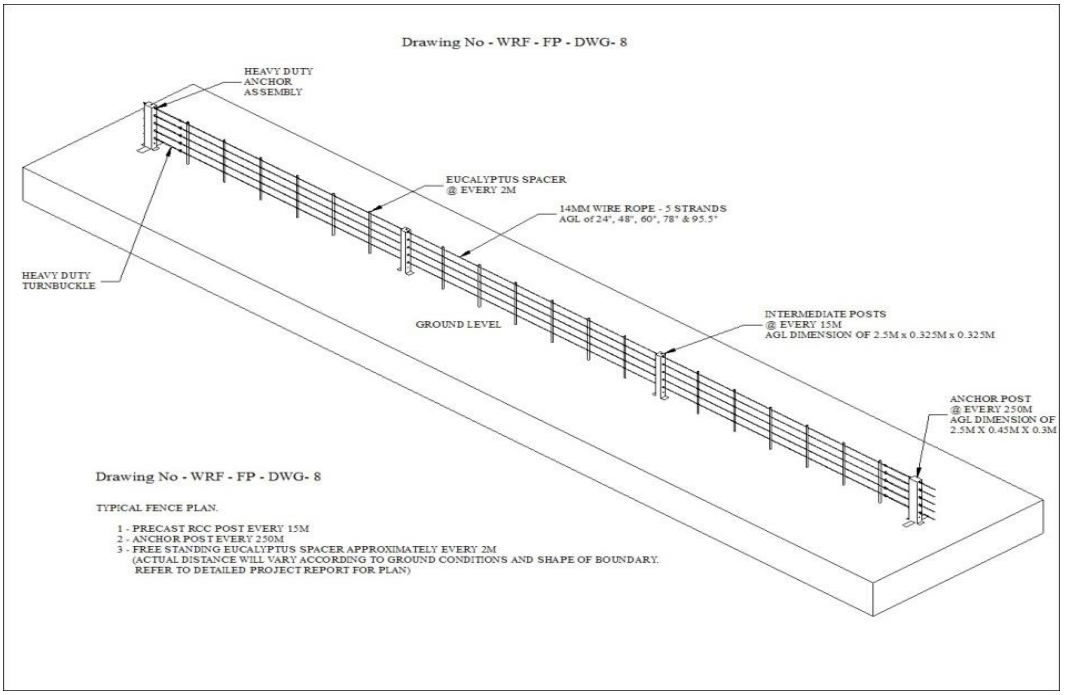
Details of Steel Wire Rope Fence

The steel wire rope fence is completely a physical barrier intending to contain elephants by its strength and design. It consists of 5 strands of steel wire ropes fixed to precast steel reinforced concrete posts. The basic specifications are as follows:

1. 14mm galvanized steel wire rope of construction 6 x19, of 1960N/mm^2 tensile strength ofminimum breaking force of 12 kN, fixed with suitable galvanized wire rope clamps.
2. Intermediate Post: The post has a minimum sectional dimension of 300 mm x 300 mm (upgraded to 325x325mm), cast in M30 grade concrete. The post has a section moment capacity of 119 kNm and shear capacity of 149 kN. The height of the post above ground level was 2.5 m. The balancing fins of the post acts against the soil substrate and provides the reaction moment to counter the force applied by an elephant on the post. The design of the balancing fins will depend on the load bearing capacity of the soil. Holes along the neutral plane of the post at heights of 2.42 m, 1.98 m, 1.524 m, 1.066 m and 0.61 m above ground level, receive the steel wire ropes strands. The Intermediate Posts are fixed along the fence line at an inter-distance of 15 m.

3. Anchor Posts: Anchor Posts are provided at every 250 m along the fence line, and the wire ropes are fastened to them through turnbuckles and anchor assemblies. They perform the function of a straining post. The Anchor Posts have two perpendicularly placed balancing fins. The smaller of the fins balances the force generated by an elephant acting on the post.The larger fin balances the combined moment of the strain of wire rope. The Anchor Post has a cross-sectional dimension of 450 mm x 300 mm. The Anchor Post is cast in M30 concrete. Holes passing through the centre of the post accept steel anchoring assemblies and turn buckle arrangements for fixing and tensioning of the wire rope.
4. Auxiliary Support: Eucalyptus poles each approximately 2.5 m long with a minimum girth of 0.4 m and are fastened every 2 m along the fence using 8 mm wire rope and wire ropeclamps.

5. The detailed design of the fence such as placement of the posts, design of the balancing fins will be site specific depending on the topography and soil conditions. Hence a site survey and detail project report are essential for effective implementation.



Appendix
Log Frame Theory / Evaluation Matrix for HEC Study

Sl. No.	Evaluation Questions	Sub Questions	Key indicator	Data source	Data Collection method	Data Analysis
1.0	**Structure of Barriers**					
1.1	What is the need and functioning of different type of barriers in other States and other countries	1. Type of barriers / barricades 2. Compensation norms 3. Best practices for mitigating HECin their experience?	• Length of barriers erected • Compensatio npaid	Published literature / reports discussion with Forest Department	Published literature / reports discussion with Forest Department	Analysis on barriers erected and compensation paid
1.2	What are the different kinds of barriers erected in the study area in the past 2 decades? What is the magnitude of each type of barrier and in combination in proportion to the forest boundaries	1. What is the length of type-wise barricades constructed during 1999-2000 to 2018-19? 2. What is the length of barricades in combination with other type of barricades? 3. Whether barriers are continuous or dis- continuous with forest boundary. 4. What is the basis for erectingdifferent type of barriers?	• Average length of barrier construction based on past data available. • Trend analysis between years and type of barrierserected	KFD / District Level Office of KFD	Structured uuestionnaire for collecting information at Division level	Trend analysis between years and type of barriers and eventually linking it to data on crop damages and compensation
1.3	Proportion of forest boundary covered by different type of barriers	1. Whether contiguous barricades erected along forest boundary 2. If not, reasons for the same – terrain / forest patches are fragmented/ no clear boundaries 3. What is the length of continuousforest boundary and length of barriers erected thereof?	• Type of barriers and Gap between forest boundary and barriers erected.	KFD / District Level Office of KFD	Structured questionnaire	Assessment of gap between length of boundary and barriers erected across all barriers and whether these

Evaluation Study on Human Elephant Conflict

Sl. No.	Evaluation Questions	Sub Questions	Key indicator	Data source	Data Collection method	Data Analysis
		4. What is the fragmented patch of forests and extent of barriers erected in these fragments?				openings result in HEC.Reasons for not having continuous barriers
1.4	What is the effectiveness and efficiency across all types of barriers and their combination?	1. What is the number of crop and property damages, injuries, and death during 2009-10 to 2013-14 vis–a-vis 2014-15 to 2018-19? 2. What is the compensation paid during 2009-10 to 2013-14 vis–a- vis 2014-15 to 2018-19? 3. What is the relationship across all types of barriers and compensation paid in sample villages and stateduring the study period? 4. Whether the barriers have been effective in reducing the crop damages? 5. If so, which one of those and in combination was effective?	• Crop damages and compensation paid during study period • Crop damages and compensation paid before study period	KFD / District Level Office of KFD	Questionnaire	Trend analysis between two periods and overall effectiveness across barriersin mitigating HEC
1.5	What is the quality level of barriers in sample location?	1. Whether technical specifications of barriers adhered – verification 2. Whether barriers are maintained ornot 3. If not, reasons for non-maintenance – resource constraints / shortage of manpower / non-cooperation by farmers 4. Whether KFD created awareness	• Quality of work asper specifications • Maintenance of thesebarriers	Field visit and inspection at various places for different type of barriers	Questionnaire	Analysis on status of quality of work executed and maintenance. Reasons for lack of maintenance

Sl. No.	Evaluation Questions	Sub Questions	Key indicator	Data source	Data Collection method	Data Analysis
		amongst farmers before erecting barriers 5. Any training / capacity building taken up amongst farmers on monitoring and maintaining of barriers 6. Whether cooperation forthcoming from community / farmers in maintenance of barriers 7. Whether farmers themselves have erected any barriers around their cropped area				and to overcome them
1.6	What is the life cycle of the barrier and reasons for failure in general and specific to locations?	1. What are the lifecycles of different type of barriers 2. What are the current status of these barriers? 3. If the barriers are not maintained, reasons for the same. 4. Is there any specific location where major failure of barrier is noticed and possible reasons	• Expected life cycle v/s. actual condition	KFD / Field visit and inspection	Questionnaire	Analysis of current status of barriers in comparison to expected life cycle and reasons for failure, due to resources – Money and man power
1.7	What is the most effective single or combination of barriers to contain wild elephant raids and reduce the cost of compensations?	1. What are the number of crop and property damages and also injury and death during the study period? 2. What is the compensation paid in relation to the type of barriers erected in sample villages? 3. What is the compensation paid in the locations with single or	• Type of barriers either single or combination • Compensation paid in each case (single / combination)	KFD / Field visit and inspection	Questionnaire	Deciding on most effective barrier either single or combinations after analysing the quantum of compensation

		combination of barriers?				paid across all barriers
1.8	What are the other complementary measures for mitigating HEC?	1. Are there any anti depredation squads engaged on a regular basis 2. Is there any crop guard on a regular basis 3. Whether NGOs / farmers involved in driving elephants 4. Is there any communication network among villagers to forewarn about possible raids? 5. What is the possibility of using drones with bee humming sound to drive elephants? 6. Is there any possibility of changes in cropping pattern? 7. Is there any possibility of using crops deterrent to elephants like chillies ? 8. Is there any measures farmers wants to adopt to mitigate the conflicts	• Innovative ideas adopted by farmers • Changes in the cropping pattern	Field visit and inspection / interaction with farmers / public /NGO	Questionnaire	Analysis on crop compensation paid in areas where the new methods have been adopted and number of cases. Extent of co operation of villagers and farmers open to other methods and also being proactive
1.9	Are there any effective barricade models adopted in different States and explore possibilities of their adoption in the State?	1. What are the effective barricade model in other states 2. Whether these models are existing in Karnataka 3. If not, what is the possibility of adopting in Karnataka ?	• Different types of barricade used in the other states • Type of barriers used in the State	Published literature / discussion with FD of other two States	Questionnaire	Analysing the different barricade or combination in other states and whether it can be replicated here if not done

						already
2.0	**Cost – Benefit Analysis**					
2.1	What is the magnitude of both physical & financial investment in taluk/ Range & districts?	1. What is the length of barricades – type-wise constructed in the study period 2. What is the expenditure on different type of barricades constructed in the study period 3. The above statistics will be sought for range / district wise if taluk-wise not available.	• Average length of barriers constructed • Amount spent across the barriers • Compensation paid	KFD / District Level Office of KFD	Questionnaire	Analysis of physical and financial achievements will give an idea of the quantum spent on mitigating HEC
2.2	What is the cost benefit across different type of barriers in form of crops saved and reduction of compensation paid and achieving safety to human life and wildlife saved? What is the estimated optimal investment in barriers that results in minimising the HEC?	1. What is the investment made across all types of barriers during the study period and five years before the study period 2. What is the compensation paid during study period and five years before? 3. What is the number of cases of crop / property damages, injuries and human death and also elephant death in the study period and five years before	• Amount spent on construction of barriers • Compensation paid. • Number of cases of compensation paid	KFD / District Level Office of KFD	Questionnaire	Cost benefit analysis across all barriers will give an overall picture of the investment made and the benefit derived from the intervention
2.3	Estimated budget requirement for covering the remaining forest boundaries with effective barriers in next 5 years in study area.	1. What is the length of different type of barriers proposed to be erected during the next five years in study area? 2. What is the investment required for proposed barriers during the next five years in study area? 3. Has KFD initiated any such	• Types and length of barriers to be constructed • Estimated cost for each barrier • Financial outlay district wise / division wise	KFD / District Level Office of KFD	Questionnaire	Analysis on budget requirement based on the effective barrier either singly or in combination

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Sl. No.	Evaluation Questions	Sub Questions	Key indicator	Data source	Data Collection method	Data Analysis
		proposal / plan for seeking budgetary allocation for future barricades				and projection of requirements
3.0	**HEC Issues**					
3.1	What is the distribution of raids over time and locations and potential reasons for straying of wild elephants?	1. What is the number of raids – location-wise – village, , - type of crops - distance from forest to raided area 2. Whether sufficient food and water available in natural habitat 3. Month wise raids 4. Whether raiding herds have been identified and whether they are different or same group raiding the same area – season after season – studying the pattern to identify the raiding herds	• Number of raids location-wise / month wise. • Crops raided	KFD / District Level Office of KFD / Field Visit	Through structured formats	Analysis on location-wise / Month wise distribution of raids. Whether the raids are by habitual herds or otherwise which can be linked to conditions existing in the area
3.2	What are the high, moderate and low risk areas and priority areas for suitable barricading (based on secondary and primary data).	1. What is the number of raids during study period – sample village-wise 2. What is the compensation paid during study period – sample village-wise 3. What are the priority area and most suitable barriers which proved effective	• Areas with maximum number of raids • Month wise information of raids • Quantum of compensation paid	KFD / District Level Office of KFD / Field Visit	Through structured formats	Analysis of high, moderate & low risk areas & priority area for barricading and need to attend to such areas on priority basis.

Sl. No.	Evaluation Questions	Sub Questions	Key indicator	Data source	Data collection method	Data Analysis
3.3	What is the quantum of ex-gratia paid over the period and its adequacy? Are there any problems in payment of ex-gratia?	1. What is the compensation paid during study period – sample village-wise 2. Whether the compensation was adequate as per beneficiary. 3. If not adequate, reasons – shortage of resources, revisions required in compensation guidelines	• Compensation paid year wise • How many times it has been paid? • Time of payment • When was it paid – Time lapse between raid and payment?	KFD / District Level Office of KFD / Field Visit	Through structured formats	Analysis on compensation paid, and its time will address the issue of timelypayment. Whether it is adequate or not, if not needs revision.
3.4	What are the issues pertaining to ex-gratia – based on case studies.	What are the issues pertaining toe ex-gratia payment – adequacy, timely payment, procedural delays, prompt payment etc., in respect of identified case studies	• Amount of compensation paid • When was it paid? • Time lapse between the event and compensation paid • Paid in one instalment or multiple	Field Visit / Interaction with public / case studies	Structured formats	Narration of case studies and analysing the compensation paid in and the time of payment and ease of payment. Its adequacy willbe analysed.
3.5	Whether people are satisfied in provision of protection to human life and crops.	What is the opinion of farmers / public/NGO about measures taken by KFD to mitigate HEC in terms of protection to human life and crops	• Number of people satisfied • Number of people somewhat satisfied • Number of people not satisfied	Field Visit / Interaction with public/NGO	Structured formats	Analysis of people ‘s response forthe quantum of compensation and measurestaken by KFD to reduce the

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Sl. No.	Evaluation Questions	Sub Questions	Key indicator	Data source	Data Collection method	Data Analysis
						mitigation.
3.6	Socio – economic fallout of HEC	1. Whether farmers affected are newly settled or earlier settlers in the area 2. What is the response from new settlers / earlier settler to conflicts? 3. Psychosocial features of affected persons – state of health, productivity, economic condition and mental health	• Qualitative indicator in terms of Socio-economic impact	Field Visit / Interaction with public	Structured formats	Analysis on socio- economic impact andthese indirect effects of theHEC needs tobe addressed
4.0	**Other Issues**					
4.1	Whether conflict hot spots have been mapped	1. In each of the districts/Divisions whether any map with high risk areas marked are identified 2. If so, any special or focused approach to those have been planned	• Areas with maximum and minimum depredation cases • Maximum and minimum compensation paid	KFD	Structured formats	Analysis helpsin reducing theconflict after prioritising high risk and low risk areas based on number of cases and compensation paid and their relations
4.2	Whether any efforts made to identify raiding herds	Identifying raiding herds and monitoring their movement has been done?	• Whether any raids have been identified or not	KFD/Villagers	Structured Format	Helps in long-term measures

Sl. No.	Evaluation Questions	Sub Questions	Key indicator	Data source	Data Collection method	Data Analysis
4.3	Whether elephants preferred tree species and grasses as it occurs in natural habitat and are they available adequately in forests	Any study has been made on carrying capacity of elephants in any of these areas	• Qualitative indicators - Elephants straying regularly even during monsoons in search of food	KFD/Villagers	Structured Format	Necessary to take measureswithin forest area to augment resources
4.4	Understanding the behaviour of elephants about crop raids	1. Whether elephants' resort to crop raiding out of necessity of for foraging 2. Whether mitigation measures are based on these above observations/studies	• Month wise compensation cases	KFD/Villagers	Structured Format	Needed to planfor result oriented output in termsof mitigation measures

Evaluation Study on Human Elephant Conflict - The Mitigation Methods Employed and its Impact on Conflict Resolution

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