

Economic Fallout of Crop Raiding on Coffee Plantations in Central Western Ghats of Karnataka

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ABSTRACT

The present study conducted in the Central Western Ghats of Karnataka, India, focused on the economic threat posed by wildlife crop raiding on coffee plantations. The primary data were collected from 100 respondents during 2022-23 and secondary data were collected from the Department of Forest, Government of Karnataka. The number of crop raiding cases reported has showed positive CAGR over the period from 2013 to 2023. The primary wildlife species responsible for crop raiding were identified as the Asian elephant (*Elephas maximus*) and Indian Gaur (*Bos gaurus*). Asian elephants accounted for 95.06 per cent of the crop raiding incidents, while Indian Gaur accounted for the remaining 4.94 per cent. The analysis unveiled a robust and statistically significant correlation between the number of reported crop raiding cases and the elephant population. According to farmers' perception, the major causes of crop raiding were food scarcity in forest and attractive crops in farm lands followed by increase in the wildlife population in the study area. The annual economic loss per household was Rs.66,128 and the total income lost for the remaining economic life of the coffee plantation was Rs.12,60,002. Based on these findings, the study recommended the adoption of better conflict mitigation measures like solar fencing to minimize losses caused by wildlife crop raiding on coffee plantations in the Central Western Ghats of Karnataka. Implementing effective strategies to address habitat destruction, improve food availability for wildlife and manage the increasing wildlife population could help reduce the economic impact on coffee farmers.

Keywords : Crop raiding, Coffee plantation, CAGR, Ex-gratia, Economic loss

HUMAN-WILDLIFE CONFLICT (HWC) is an interaction between wild animals and the people and the resultant negative impact on people and/or their resources or wild animals and their habitat. It occurs when growing human population overlap with established wildlife habitat, causing damage to resources or life to some people and wild animals (Ramakrishnan, 2007). The word conflict is defined as incompatibility between opinion and principles. In many parts of the world, HWC is one of the alarming threats to life and survival of many species, and is also a significant threat to many local human populations. Human-Wildlife conflict has been

defined as any interaction between humans and wildlife that results in negative impact on human, social cum economic or cultural life, on the conservation of wildlife population or on the environment. Human-wildlife conflicts are the product of socio-economic and political landscapes and are contentious because the resources concerned have economic value and species are often high profile and legally protected. Many products from wild animals and their habitat are of high economic value to human beings rendering them to remain in conflict continuously. The conflict takes many forms ranging from loss of life or injury to humans and animals both

wild and domesticated, to compete for the scarce resources resulting in loss and degradation of habitat. Overall, around 200 people are thought to be killed by wild animals in Tanzania annually, with man-eating lions posing a particular problem - they have been recorded as dragging people out of huts at night, attacking them in small towns and even swimming out to riverine islands in order to attack humans (Kushnir and Packer, 2019). Although in a global context, the number of human fatalities due to wild life is negligible when compared to famine, war and disease, the intensity of conflict that it generates, can have very significant impacts in terms of hostility towards conserving potentially dangerous species (Vishwanatha, 2016).

Scenario of Human-Wildlife Conflict in Karnataka

Human-wildlife conflict (HWC) presents a complex challenge in India's Western Ghats region, with Karnataka standing out as a prime example. The convergence of factors such as expanding agricultural activities and the fragmentation of once contiguous forests has created a hotbed for HWC. One of the most significant issues faced by marginalized farmers in Karnataka is the extensive crop damage inflicted by various wild animals, notably Asian elephants, Indian gaur, wild pigs, bonnet macaques and others. The encroachment of human settlements and the relentless expansion of agriculture into marginal areas have put agricultural fields in close proximity to forested regions. Consequently, this geographical adjacency has facilitated wild animal's easy access to crops, leading to substantial agricultural losses. Among the crop riders, Asian elephants and wild pigs emerge as the most significant perpetrators, causing extensive crop damage and exacerbating tensions between wildlife conservation efforts and farming communities.

In Karnataka, the strict enforcement of the Wildlife Protection Act of 1972 has successfully shielded these animals from poaching, allowing their populations to remain stable or even grow over the years, as reported in various census studies. However, this apparent success story is tempered by the fact that large-scale conversion of forests into monoculture plantations

(such as teak and eucalyptus), shifting cultivation practices, hydroelectric projects and organized encroachments have significantly diminished the available habitat for these wild animals. Consequently, HWC has become a stark reality in several locations throughout the state.

Wild animals in Karnataka are known to destroy a diverse range of crops, including staples like paddy, coconut palms and plantations, as well as cash crops such as coffee, oil palm and arecanut. This extensive crop raiding negatively affects farmer's attitudes towards wildlife conservation efforts, posing a significant challenge to effective HWC mitigation. To address this growing issue, the Karnataka Forest Department has initiated measures to provide ex-gratia payments to affected farmers, compensating them for losses incurred due to crop raiding, cattle theft, human casualties and other related incidents. This proactive approach aims to not only alleviate the economic burden on farmers but also foster a more harmonious coexistence between humans and wildlife in the region. By quantifying the actual economic losses caused by wild animals and offering financial support, there is hope that this multifaceted problem can be mitigated and the delicate balance between conservation and agriculture restored in Karnataka's Western Ghats (Chethan and Raghavendra, 2020)..

Hence, with the objective of resolving this multifaceted predicament, present study focused on addressing human-wildlife conflict in the central western *ghats* of Karnataka. By examining the intricate interplay between farmers and wild animals in this ecologically sensitive region, the study seeks to quantify the losses incurred but also propose effective strategies to foster sustainable coexistence. Through rigorous empirical analysis and comprehensive site-specific investigations, this endeavour aims to pave the way for a harmonious balance between the thriving agricultural activities and the conservation of indigenous wildlife in the region.

Objectives of the Study

Given the distinct and unique patterns of human-wild life conflict in various geographic areas, the study

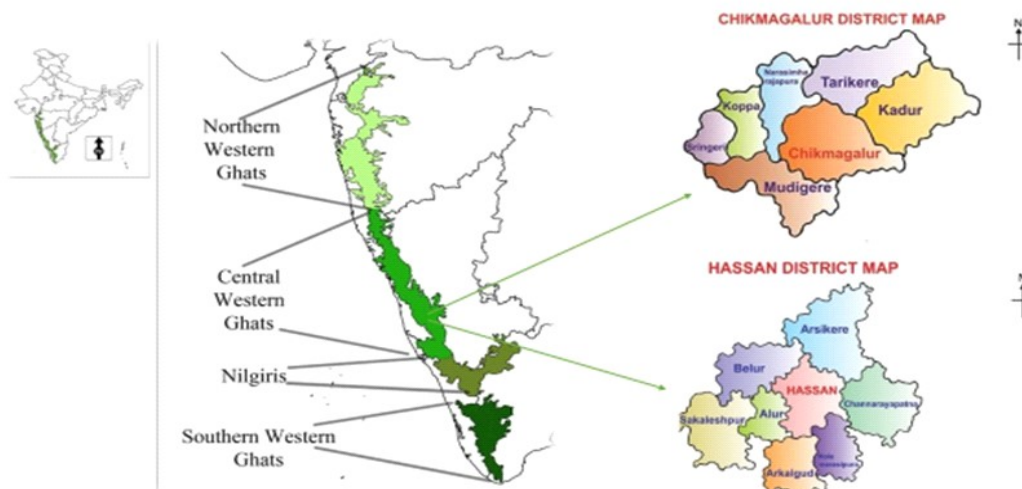


Fig. 1 : Map showing the study area

titled ‘Economic fallout of crop raiding on coffee plantations in Central Western Ghats of Karnataka’ was conducted with the following objectives-

1. To analyze the dynamics and causes for crop raiding.
2. To estimate the physical and economic loss of crop raiding.

METHODOLOGY

This section presents detailed description of the study area, the data sources, methods of collection and analysis as well as the empirical model for the study.

Study Area and Data Collection

A purposive random sampling technique was employed for the study, which was conducted in the Central Western Ghats of Karnataka, encompassing the Chikkamagaluru and Hassan forest divisions (Fig. 1). The areas with the highest number of crop raiding cases were identified in Mudigere and Sakleshpur ranges within the Central Western Ghats. To gather the primary data necessary for analysis, semi-structured interview schedules were utilized and responses were collected from a sample of 50 respondents from the Mudigere forest range in Chikkamagaluru and 50 respondents from the Sakleshpur forest range in the Hassan forest divisions. Consequently, a total sample of 100 farmers were examined (Fig. 2).

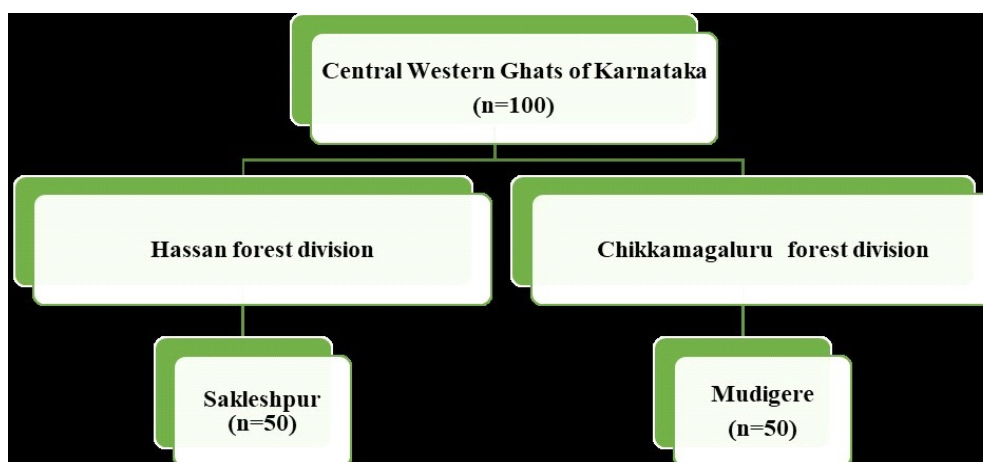


Fig. 2 : Sampling framework of the study

Analytical Tools Employed

The data on socio-economic characteristics, cost and returns from farming, constraints in getting ex-gratia, expenditure made by the government were analysed using descriptive statistics like percentages, averages and ratios and results are presented in tabular form.

Compound Annual Growth Rate (CAGR) :

To estimate the growth rate in number of crop raiding cases reported in the study area, the compound growth rate technique was employed using the following exponential function of the form of model.

$$Y = a b^t e^{ut} \dots\dots\dots (1)$$

Where,

Y = Dependent variable (No. of HWC cases reported)

a = Intercept (constant)

b = Regression coefficient

‘a’ and ‘b’ are the parameters to be estimated

t = time period

Ut = Disturbance term for the year ‘t’

The equation (1) was transformed into log linear form as below and was estimated by using the Ordinary Least Squares (OLS) technique,

$$\ln Y = \ln a + t \ln b + Ut \dots\dots\dots (2)$$

Compound growth rate (g) in percentage was computed as follows

$$g = (b-1)100 \dots\dots\dots (3)$$

Where,

g = Compound growth rate in per cent per annum

b = Antilog of g

The significance of growth rate was tested using, ‘t’ test as defined below :

$$t = \frac{r}{se(r)} \dots\dots\dots (4)$$

$$SE(r) = \frac{100 \times b1 \times SE(r)}{lne} \dots\dots\dots (5)$$

$$SE(r) = \frac{100 \times \beta \times SE(\log\beta)}{0.4343} \dots\dots(6)$$

Where,

r = Regression co-efficient

se (r) = Standard error of the regression co-efficient

Garrett ranking technique : Garrett ranking technique was used to rank the farmers perception on causes for HWC in the study area. Farmer respondents were asked to rank the causes listed. In this analysis, rank one meant most important cause and last rank meant less important. In the next stage, rank assigned to each cause by each individual farmer was converted into per cent position using the following formula :

$$\text{Per cent position} = \frac{100 \times (R_{ij} - 0.50)}{N_j} \dots\dots\dots(7)$$

Where, R_{ij} stands for rank given for the i^{th} cause ($i = 1, 2, \dots, n$) by the j^{th} individual ($j = 1, 2, \dots, 50$) and N_j stands for number of causes ranked by j^{th} individual.

After finding the per cent positions, the per cent position of each rank was converted to scores by referring to table given by Garret and Woodsworth (1969). Then the scores for each cause was summed. In this way, total scores were arrived at for each cause and then mean scores were calculated. Finally, overall ranking of the causes was done by assigning ranks in the descending order of the mean scores.

RESULTS AND DISCUSSION

Socio Economic Characteristics of Respondents

The socio-economic characteristics of the sampled respondents are detailed in Table 1. On an average, the household heads were found to be fifty-four years old and they had received an average of eight years of schooling. This suggests a relatively modest level of education within the surveyed population. Regarding family size, the data revealed that the average household consisted of five members, indicating that

TABLE 1
Socio economic characteristics of respondents

Particulars	(n=100)
Age of household head (Years)	54.00
Years of formal education (No.)	8.00
Family Size (No.)	5.00
Land holding (acre)	7.57
Rainfed (acre)	1.09
Irrigated (acre)	6.48
Type of Farmers	
Small (less than 2 acres) (No.)	7.00
Medium (2 to 4 acres) (No.)	58.00
Large (more than 4 acres) (No.)	35.00

most households had a medium-sized family structure. This demographic insight could be significant for understanding the dynamics of these households and their resource allocation. In terms of land ownership, the average landholding size was 7.57 acres. This figure is further broken down into 1.09 acres of rain-fed land and 6.48 acres of irrigated land, highlighting the mix of agricultural practices in the area. Notably, a substantial majority of farmers, constituting 58 per cent of the study area's population, fell into the medium-sized category, with land holdings ranging from 2 to 4 acres. This information provides valuable context for assessing the socio-economic landscape of the region and its implications for agricultural practices and livelihoods.

Causes of Crop Raiding

The researcher inquired with farmers in the central Western Ghats of Karnataka regarding the causes of crop raiding. The findings have been presented in Table 2 and the analysis was conducted using the Garrett ranking technique. The results indicate that food scarcity emerged as the primary cause for crop raiding, with a Garrett score of 75.73. Following closely behind were attractive crops in farmland (64.47), proximity to forest fringe villages (56.60), inadequacy of preventive measures (52.60), an increase in wildlife population (49.60), a rise in human population (47.70), elephant migration (46.33)

TABLE 2
Farmers perception on causes of crop raiding in the study area

Causes for crop raiding	Garrett score	Rank
Food scarcity in forest	75.73	I
Attractive crops in farmlands	64.47	II
Forest fringe villages	56.60	III
Inadequacy of preventive measures	52.60	IV
Increase in wildlife population	49.60	V
Increase in human population	47.07	VI
Elephant migration	46.33	VII
Diversion by chasing of wild animals	31.40	VIII

and diversion due to chasing of elephants (31.40) and these findings are in line with the earlier studies conducted by Govind & Jayson, 2021 and Lingaraju, 2017.

Human Wildlife Conflict Cases Reported in the Study Area

The instances of crop raiding and the total reported human-wildlife conflict (HWC) cases in the Hassan, Chikkamagalur forest divisions and Karnataka are presented in Table 3. Over the years, there has been an annual increase in HWC cases at a rate of 2.98 per cent. For the past decade, from 2013-14 onwards, the average number of reported HWC cases has consistently been 30,308. Similarly, crop raiding cases have also seen an upward trend, with an annual increase of 0.68 per cent in Hassan and a more substantial increase of 7.15 per cent in Chikkamagalur forest division, as indicated in Fig. 3. However, it is worth noting that despite the higher rate of increase in Chikkamagalur, the average number of crop raiding cases reported remains higher in Hassan (3256) compared to Chikkamagalur (1563). The results revealed that the growth in crop raiding cases is not significantly escalating in the study area, farmers in Hassan are experiencing a greater burden of crop loss due to wild animals. Furthermore, it is noteworthy that crop raiding cases constitute a substantial portion of the total reported human-wildlife conflict cases in

TABLE 3
Human wildlife conflict cases reported in the study area
(in Number)

Year	Hassan		Chikkamagalur		Karnataka	
	Crop raiding	Total cases	Crop raiding	Total cases	Crop raiding	Total cases
2013-14	2653	2823	1028	1071	19136	20268
2014-15	4549	4965	1604	1687	53879	55626
2015-16	3475	3805	934	993	21150	23149
2016-17	2248	2670	1088	1134	18985	21327
2017-18	2896	3332	1115	1182	20295	23092
2018-19	3842	4282	1946	2047	27525	30816
2019-20	2336	2772	1246	1298	20951	23466
2020-21	3636	4272	1380	1462	24667	28425
2021-22	2635	3321	2627	2756	31255	36870
2022-23	4285	4582	1798	2001	33234	40042
Total	32555	36824	14766	15631	271077	303081
Average	3256	3682	1477	1563	27108	30308
CAGR	0.68 ^{NS}	1.52 ^{NS}	7.15 ^{NS}	7.51 ^{NS}	1.54 ^{NS}	2.98 ^{NS}

Note : NS-Non-significant; Source : Department of Forest, Government of Karnataka, 2023

TABLE 4
Species wise nature and extent of damage due to crop raiding

Wild animals	Nature of damage	Frequency per year	Extent of damage (%)
Elephant	Trample on coffee bushes Damaging or uprooting Breaking branches Destruction of infrastructure (fences, irrigation systems, and others)	1-10 times	95.06
Indian gaur	Crop foraging Trampling of coffee bushes and young plants Damage to fences, irrigation systems, and other.	0-5 times	4.94

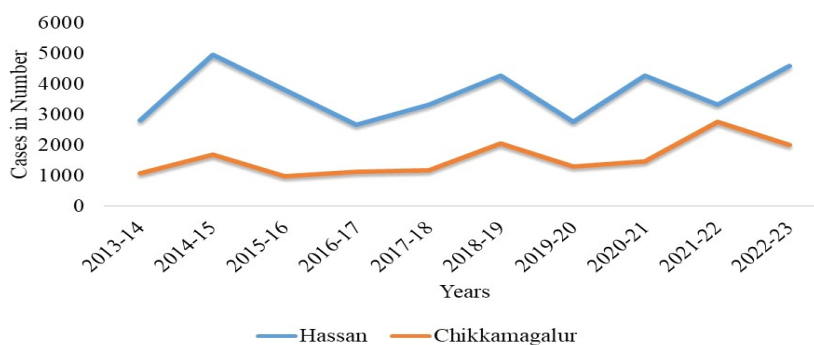


Fig. 3 : Dynamics of human wildlife conflict in the study area
Source : Department of Forest, Government of Karnataka, 2023

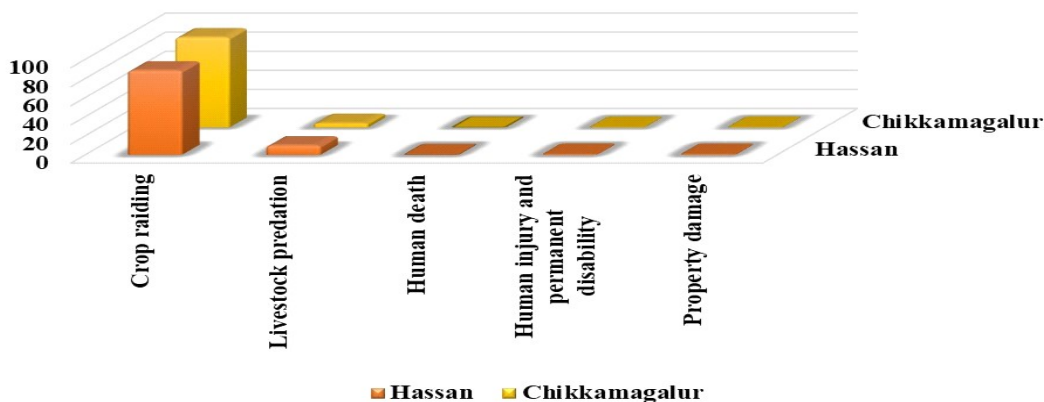


Fig. 4 : Share of human wildlife conflict cases in the study area from 2013 to 2022
 Source : Department of Forest, Government of Karnataka, 2023

the study area, as depicted in Fig. 4. This under scores the significant impact on farmers who are bearing the brunt of crop losses resulting from interactions with wildlife.

The second most traded commodity after oil in the world is coffee (Soujanya *et al.*, 2023). To estimate losses, it is imperative to comprehend the nature of the damage. A comprehensive analysis of damage types in the study area yielded noteworthy findings. Damage resulting from elephant interactions encompassed trampling of coffee bushes, the damaging and uprooting of coffee plants, breaking of branches, and the destruction of vital infrastructure such as fences and irrigation systems. Conversely, when it came to Indian gaur, the primary nature of damage involved trampling coffee bushes and young plants. Additionally, the analysis delved into the

frequency of these damage incidents per year, revealing a range of one to 10 incidents annually for elephants, with some farms experiencing just one incident while others faced up to 10 raids per year. In contrast, incidents involving Indian gaur ranged from 0 to 5 per year. Notably, the analysis highlighted that approximately 95.06 per cent of the extent of damage was attributable to crop raiding by elephants, while the remaining 4.94 per cent was linked to Indian gaur-related incidents. These insights furnish valuable information regarding the patterns and types of damage inflicted by wildlife in the study area and they are consistent with the findings of Karanth *et al.*, 2013.

As observed earlier in Table 1, the incidence of crop raiding cases has shown a consistent increase over the years. Similarly, when examining the elephant population based on data from previous elephant

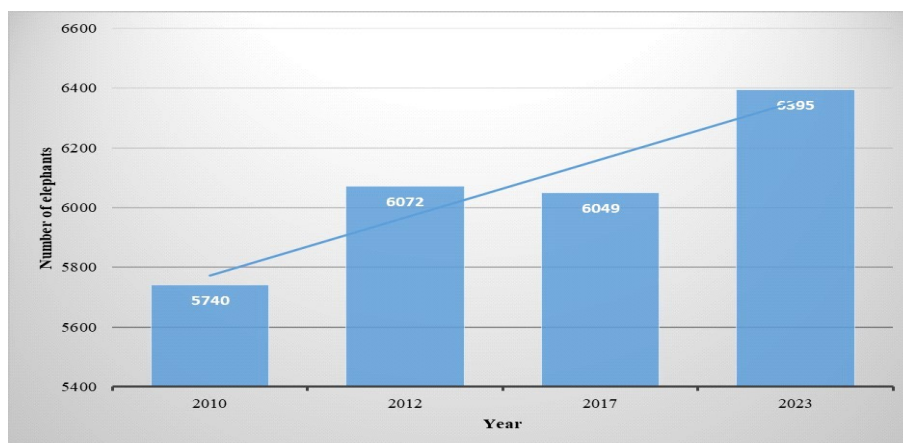


Fig. 5 : Elephant population in Karnataka
 Source : Department of Forest, Government of Karnataka, 2023

censuses, there has been a notable upward trend in the elephant population (Fig. 5). To explore the potential relationship between the number of crop raiding cases and the elephant population, the researcher conducted a correlation analysis, taking into account the total number of reported crop raiding cases in Karnataka alongside the elephant population.

The results unveiled a robust and statistically significant correlation between the number of reported crop raiding cases and the elephant population. Specifically, the correlation coefficient was calculated to be 0.859 (Table 5), indicating a strong positive correlation between these two variables. This finding suggests that as the elephant population has increased, so too has the incidence of crop raiding cases,

TABLE 5
Correlation between elephant population and crop raiding

Particulars	Elephant Number	Crop raiding
Elephant Number	1	
Crop raiding	0.859	1

highlighting the intricate relationship between human-wildlife conflict and elephant numbers.

The comprehensive assessment of both the physical and economic losses resulting from crop raiding incidents revealed that the losses amounted to 28,522 coffee plants due to elephant raids and 1,035 plants due to Indian gaur encounters. In economic terms,

this translated to a total yield loss of approximately 547.49 quintals, leading to an annual economic loss estimated at 66.12 lakh rupees. On an individual household basis, this equated to a loss of Rs. 66,000 in the study area. The calculation of annual economic loss was based on multiplying the total number of plants lost due to crop raiding by the gross returns typically obtained per coffee plant. However, it's essential to consider the long-term impact as well. If farmers had not experienced crop raiding incidents, coffee plants would have been able to yield their full economic potential over their entire lifespan. Therefore, accounting for the lifetime economic loss due to crop raiding is crucial. The analysis accounted for the lifetime economic loss by multiplying the annual economic loss by the remaining economic life of the affected coffee plants. This calculation revealed a substantial lifetime economic loss per household, amounting to Rs.12,60,000. This significant loss not only impacts current income but also carries implications for future household income (Table 6).

Both the central and state governments have been actively taking measures to mitigate the human-wildlife conflict cases in Karnataka. One such initiative by the state government involves the provision of ex-gratia payments to compensate for the losses incurred due to wildlife-related incidents. However, it is worth noting that these payments may not cover the full extent of the losses. Over the years, there has been a notable increase in the ex-gratia payments made towards crop raiding incidents. In the fiscal year 2013-14, the amount

TABLE 6
Physical and economic losses due to crop raiding on coffee plantations

Wild animal	Total Plant loss (No.)	Total Yield loss (q)	Annual economic loss (Rs.)	Lifetime economic loss (Rs.)	Plant loss Per household (No.)	Yield loss Per household (q)	Annual economic loss per household (Rs.)	Lifetime economic loss per household (Rs.)
Elephant	28,522	529.69	66.12 lakh	1260 lakh	285.22	5.297	66,128	12,60,002
Indian Gaur	1,035	17.81			10.35	0.178		
Total	29,557	547.49			295.57	5.475		

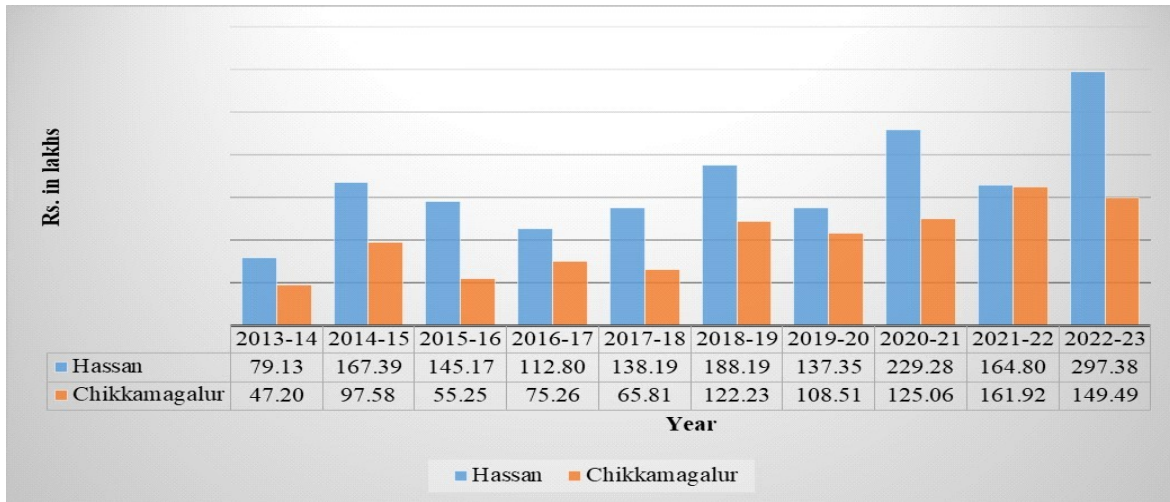


Fig. 6 : Ex-gratia paid towards crop raiding in the study area
 Source : Department of Forest, Government of Karnataka, 2023

disbursed for this purpose stood at 79.13 lakh rupees in Hassan forest division and 47.20 lakh rupees in Chikkamagalur forest division, as indicated in Fig. 6. This increase in ex-gratia payments can be attributed to the rising number of crop raiding cases. By the most recent data available, the ex-gratia payments have further escalated, reaching 297.38 lakh rupees in Hassan forest division and 149.49 lakh rupees in Chikkamagalur forest division. This upward trend in payments aligns with the continued increase in crop raiding cases, emphasizing the growing financial

burden on the government to compensate for losses incurred by farmers due to human-wildlife conflicts (Ogra and Badola, 2008).

Despite the government’s provision of ex-gratia payments for Human-Wildlife Conflict (HWC) cases, farmers have encountered difficulties in accessing these funds through the respective Range forest offices. In an effort to understand the specific challenges faced by farmers in this regard, the researcher conducted interviews with respondents

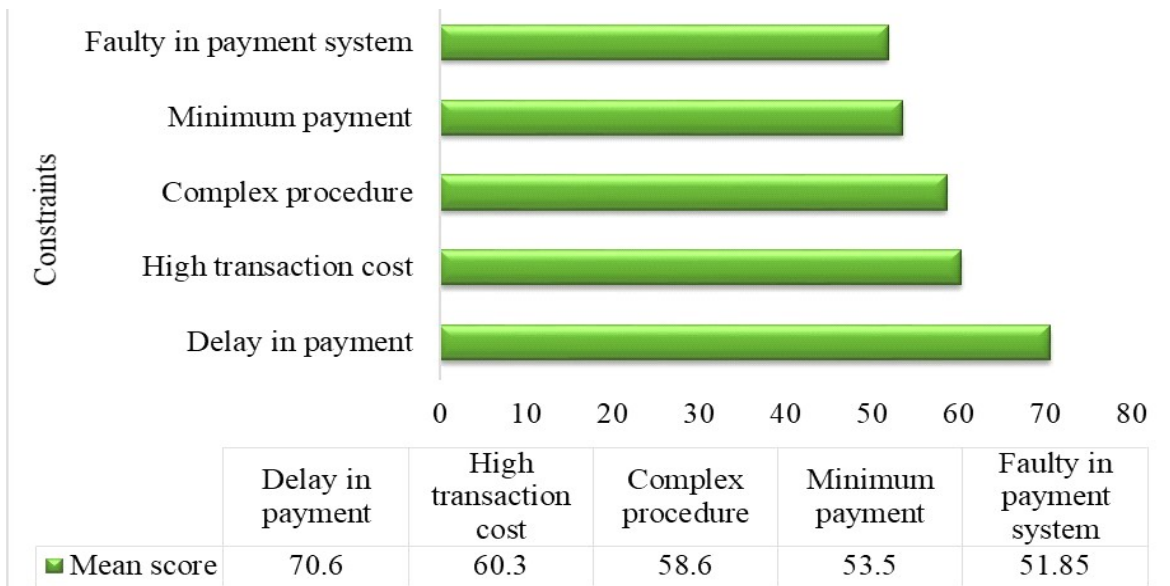


Fig. 7 : Constraints in getting ex-gratia by coffee planters

and employed the Garrett ranking technique for analysis. The results shed light on the primary issues confronted by farmers: delay in payment stands first rank with a Garrett score of 70.60 (Fig. 7), as the process from application to disbursement often spans 8-10 months, leading to incurred transaction costs (Second ranked). The complexity of the application procedure emerged as the third-ranked issue, requiring farmers to navigate through intricate bureaucratic steps and documentation. Ranked fourth, farmers indicated that the amount provided by the forest department as ex-gratia payment was minimal, failing to adequately cover their losses due to HWC incidents. These findings underscore the need for streamlining and improving the ex-gratia disbursement process to ensure that farmers receive timely and sufficient compensation for the losses they endure as a result of human-wildlife conflicts. Addressing these challenges can play a pivotal role in alleviating the financial burden on affected farmers and fostering more effective conflict mitigation strategies. The current findings align with the results reported by Karanth *et al.*, 2018.

Conclusion and Policy Recommendations

In summary, this paper has brought to light the substantial economic repercussions resulting from crop raiding incidents in the central Western Ghats of Karnataka. Over the past decade, there has been a notable increase in human-wildlife conflict cases, with crop raiding as a dominant issue. Thus, our initial hypothesis is validated. Each household in the study area has incurred an annual economic loss averaging Rs.66,128. Moreover, considering the potential loss of coffee plantations over their remaining economic lifespan, the total income reduction amounts to a substantial Rs.12,60,002. These losses not only impact current agricultural yields but also cast long-term shadows on the livelihoods and income prospects of affected households. This underscores the urgent need for the implementation of effective mitigation measures to alleviate the burden of human-wildlife conflicts on the region's farmers.

To address this issue, it is strongly recommended to adopt enhanced conflict mitigation strategies such as

the installation of solar fencing to minimize losses caused by wildlife crop raiding on coffee plantations within the central Western Ghats of Karnataka. Simultaneously, proactive measures aimed at preserving wildlife habitats and enhancing food availability for these animals can contribute to reducing the overall economic impact on coffee farmers. This comprehensive approach holds the potential to mitigate the challenges posed by human-wildlife conflicts and foster sustainable coexistence in the region.

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