

# A COMPELLING NEW VIRTUAL APPROACH TO MITIGATE ELEPHANT CHALLENGES!

## The chilli-string phenomenon to mitigate HWC conflict.

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**Introduction:** This strategy primarily targets elephant approaching crop clusters from a PA or a 'safe' undisturbed place (place of refuge), following the Tsholotsho and Victoria Falls community protocol discovery, hindering approach pathways elephant *purposed travel* along to access places of mischief! Investigative trialling in Tsholotsho, Mbire and more recently in the Binga and Hurungwe RDC community Wards in Zimbabwe, has shown significant repellence occurring placing interventions outside the *habituated zone* (see figure 1), where elephant least expect a challenge, before crossing the risk interface (SVB); from the comparative safety of a refuge area, travelling toward riskier territory.

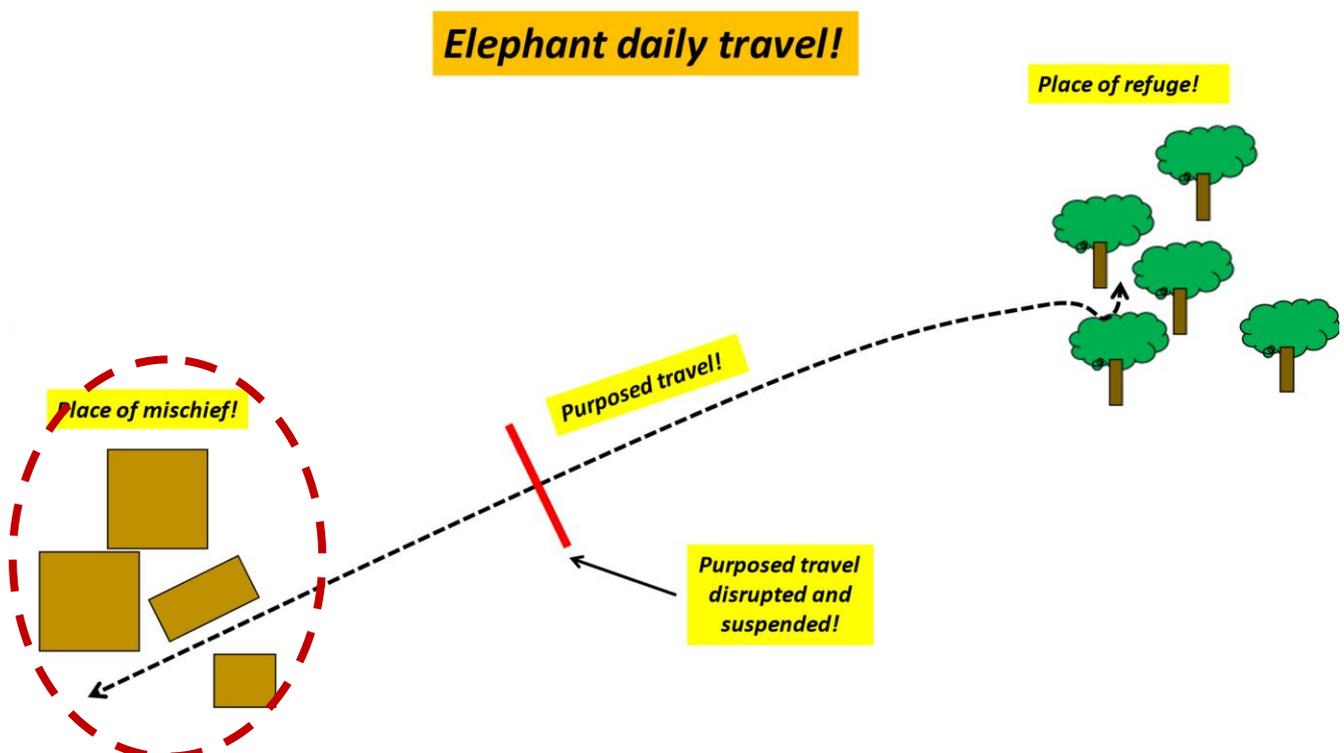


Figure 1 Elephant daily travel from refuge to cropped lands.

This approach represents a physiological intervention measure rather than a physical one, exploiting natural animal behavioural traits, in particular *suspicion of anything new, effectively formatting and maintaining a virtual boundary at that position*. Early criticism of the concept centred around the fact that viewed as a physical barrier, the measures placed appeared haphazard and flimsy, easily pushed through.

To field test the concept and strategy, we set up a number of chilli-string positions throughout the cropping and community villages in Mbire RDC, along appropriate approach paths identified, that linked day refuge places to the crops raided; daily passage, '*purposed travel*' routes to places of mischief. These were monitored by respective Ward scouts collecting data recorded against the KoboCollect platform, recording visits and activity around the chilli-string

positions, comparing data against community perception for each observation, to determine the effectiveness of the intervention to repel depredating animals.

**Experimental design and preliminary field data results collected in the Mbire RDC, adding comment to these observations when necessary to clarify the data recorded:**

This study presents preliminary descriptive statistics for the chilli-string barriers set for both the 2019/2020 and 2020/2021(November to March) cropping seasons to mitigate crop raiding animals, including depredating hyena. The community and local authority game scouts (resource monitors) recorded 180 chilli-string barrier observations from 82 set positions, blocking access along specific approach pathways, problem animals travelled along from their places of refuge to places of mischief (**Table 1, 2 and Map 1**).

*Table 1: Number of KoboCollect observations monitoring chili-string positions by Ward in Mbire RDC*

Ward Name	Observations	Percent
Angwa Ward 2	18	10.23
Bwazi Monoz Ward 16	1	0.57
Chitsungo Ward 10	86	48.86
Gonono Ward 4	18	10.23
Kanongo Ward 3	12	6.82
Kanyemba Ward 1	28	15.91
Masoka Ward 11	13	7.39
Total	176	100

*Note:* through KoboCollect malfunction, in 4 of the 180 positions, observations could not be geographically located, so were ignored, observations drawn from 176 of the 180 observations.

**Table 2** shows the number of set chilli-string barriers visited, that were set specifically for problem species. A higher proportion of the barriers were set for elephants followed by hyenas and finally hippo. In some villages kudus, and wild pigs were reported to be problem animals and so scouts set up additional chilli-strings to mitigate them.

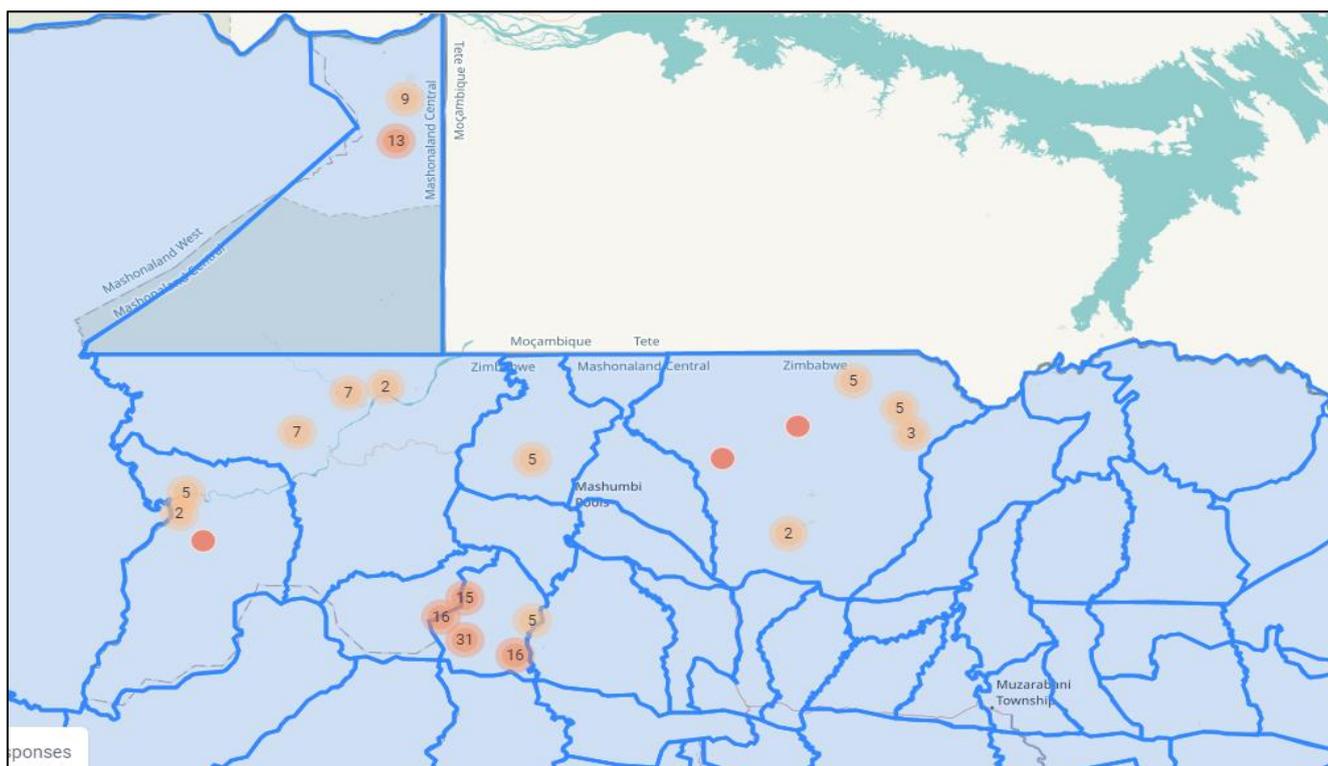
**Importantly to note:** was that the strings were not randomly placed but set specifically to intercept the problem animals in mind.

**Results of data collected by KoboCollect:**

*Table 2: Visits to chili-string barriers set specifically for target species.*

Targeted species	Freq.	Percent
Elephants	62	42.18
Hippos	27	18.37
Hyenas	47	31.97
Kudus	6	4.08
Warthogs/wild pigs	4	2.72
Other	1	0.68
Total	147	100

*Note:* that only the chilli-strings specifically set for problem species were considered for 147 from 176 observations



Map 1: distribution of chilli-string observations in Mbire RDC – numbers encircled indicating multiple repellence noted.

Monitors scouted for signs of animal activity at each of the barriers visited. **Table 3** shows that in approximately in 43% (73) observations, there was direct evidence of the targeted problem animal species having approached the chilli-string barriers.

Table 3: Evidence of wild animal presence at the chilli-string barriers

Direct animal presence noted at the barriers?	Freq.	Percent
None	97	57.06
Animal sign noted	73	42.94
Total	170	100

*Note:* confusing results as the ‘non-visits’ may in fact have been avoidance well before the chilli-string positions effectively providing repellence as indicated by community perception provided in table 8, rather than general absentee passage as the table suggests

**Table 4** indicates the characteristics of direct animal presence observed at the chili barriers, of which the primary evidence was animal spoor. In 37% of these cases, scouts also noted disturbed vegetation around the barriers indicating elephant response approaching the barriers. In approximately 10% of cases, both monitors and farmers nearby, reported hearing vocalization of animal reaction approaching the chilli-string barriers, predominantly from elephant.

Table 4: Wild animal evidence at the chili barriers.

Evidence of wild animal presence	Freq.	Percent
Animal spoor	43	59.72
Animal spoor & disturbed vegetation	18	25.
Animal spoor; disturbed vegetation; heard sounds	6	8.33

Animal spoor; disturbed vegetation; direct sightings	3	4.17
Animal spoor; heard sounds	1	1.39
Other	1	1.39
Total	72	100

**Table 5:** Of the 62 chilli-string interactions anticipated for elephant, 33 (53%) of them indicated direct evidence of elephant presence. Evidence of hippos approaching the chilli-strings was noted at 23 of the expected 27 (85%) positions. Of the 47 chilli-string positions expected for hyena, only 10 indicated direct evidence (21%) of them. Six (6) chilli-string positions were anticipated for Kudu, of which evidence of presence was noted at 5 (83%) of them. Four (4) chilli-string barriers were set targeting wild pigs, but no direct evidence of bushpig presence was observed. Buffaloes were noted at some of the chilli barriers set for elephant.

*Table 5: Wild animal species and numbers approaching the chilli-string barriers.*

Species that approached the chilli-string barriers	Freq.	Percentage
Elephants	33	46%
Hippos	23	32%
Hyenas	10	14%
Kudu	5	7%
Duiker	2	3%
waterbuck	1	1,4%
Buffaloes	1	1,4%
Elephants Buffaloes	1	1,4%
Elephants Buffaloes Kudu	1	1,4%
Elephants Kudu	1	1,4%
Total	78	100

*Note:* interestingly observations in Mbire and elsewhere indicate that approach paths are often used by many species crop raiding, indicating multiple use of them.

To quantify the effectiveness of the barriers stopping wild animals from proceeding to the lands, KoboCollect captured how the animals behaved as they approached the chilli-string barriers. **Table 6** provides a summary of these, recording animal activity at each chilli-string barrier. In the majority of cases, animals immediately changed direction upon detecting the barriers (99,3%). In 28 of these cases (29%) there was evidence that the animals ran back upon encountering the barriers. Only in 9 cases (7%) *italics in table combining 2 results*, did wild animals cross the chilli-string barriers, of which in 5 of these, the animals panicked running through the strings, diverting, while for the remaining 4 cases, they walked through without evidence of panic, nevertheless they also diverted directly away from the chilli-string positions. In 52 instances animals, predominantly elephant, reacted violently to the intrusion of the chilli-strings, demonstrating significant aggression, more than merely running off, tusking, and digging up of the ground, burying torn off vegetation, trumpeting throwing up dust, all directed at the passive ‘invisible’ source, clearly agitated by its presence, demonstrating a virtual component playing out.

*Table 6: Wild animal behaviour recorded at the chili barriers*

Wild animal behavior at the chilli-string barrier	Freq.	Percent
Reacted violently	52	39.4%
Radically altered direction	32	24.2%
Ran back	18	13.6%
Destroyed trees; ran back; changed direction	10	7.6%

Crossed the barrier and ran	5	3.8%
Crossed the barrier and walked	4	3%
Ran back; changed direction	3	3%
Destroyed trees	2	
Destroyed trees; ran back	2	
Changed direction; Other (unspecified)	1	
Crossed the barrier and walked but changed direction	1	
Ran back; other (unspecified)	1	
Went round the barrier and maintained route	1	
Total	132	

*Note:* apparent discrepancies 132/176 being other antelope, duplication of recordings, and other anomalies arising from the KoboCollect platform

**Table 7** indicates detailed behaviour noted at each of the barrier positions: for elephant, hippo, kudu, buffalo, and hyena, that reached the chilli-string barrier sets. There were a total of 32 chilli-string positions where elephant approached the chilli-string barriers, of which in 29 cases (90%), they approached the chilli-string with intent but did not cross, either changing direction, or running back. In 31 of these cases (96.87%), elephant were totally intimidated by the chilli-string barrier and were effectively deterred from proceeding forwards on their respective *purposed travel* routes. In the 3 positions, where they crossed, in two of them, they deviated and ran off, indicating they probably approached the barrier with a tail wind coming from behind and so only scented the strings as they passed through, panicking beyond, running off. The remaining individual, although not indicating any direct evidence of recognition upon crossing the barrier, nevertheless it too immediately changed direction once crossing, away from the crops.

**Significantly, there was no evidence recorded for elephants having navigated successfully around the barriers.**

**Consultant comment** – *mitigating problem animal behaviour employing a virtual approach, physical evidence may not be observed rather consequent behavioural change, altering previous animal intent significantly!*

Of the 10 cases of hyenas approached the barriers, in 6 cases (66%), they recognised the barrier and immediately changed direction, either diverting past away from them and running on, avoiding the barrier, or turning back. Both kudu and buffalo approaching the barriers, indicated they too were dramatically deterred; evidence indicating that they both recognised the chilli-string barriers, reacting by running directly away from them. Buffalo noted attacking the surrounding vegetation on one occasion.

*Table 7: detailed animal behaviour at the chili string barrier travelling from their respective refuge areas.*

Wild animal behavior at the chili barrier	Elephants		Hyenas		Hippos		Kudu		Buffaloes	
	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
Destroyed trees ran back & changed direction	10	31.25	0	0.00	0	0.00	0	0.00	1	33.33
Changed direction	6	18.75	2	22.22	3	18.75	2	40.00	0	0.00
Ran back	6	18.75	1	11.11	0	0.00	3	60.00	1	33.33
Ran back & changed direction	3	9.38	0	0.00	0	0.00	0	0.00	0	0.00
Crossed the barrier and ran	2	6.25	1	11.11	1	6.25	0	0.00	1	33.33
Destroyed trees ran back	2	6.25	0	0.00	0	0.00	0	0.00	0	0.00
Crossed the barrier, walked, but changed direction	1	3.13	0	0.00	0	0.00	0	0.00	0	0.00

Destroyed trees	1	3.13	0	0.00	0	0.00	0	0.00	0	0.00
Other (specify)	1	3.13	1	11.11	10	62.50	0	0.00	0	0.00
Changed direction										
Other	0	0.00	0	0.00	1	6.25	0	0.00	0	0.00
Crossed the barrier & walked	0	0.00	3	33.33	1	6.25	0	0.00	0	0.00
Went round the barrier & maintained direction	0	0.00	1	11.11	0	0.00	0	0.00	0	0.00
Total	32	100.00	9	100.00	16	100.00	5	100.00	3	100.00

### Community scout perceptions regarding the effectiveness of the chilli-string barriers

During KoboCollect motoring, community game scouts recorded community perception for each of the chilli-string barriers observations, which included questioning communities to gauge their opinions as to the effectiveness of the chilli-string barriers. **Table 8:** Of the 151 anticipated animal approaches, crop guards and the resource monitors, alerted by approach sounds emanating from the direction of the chilli-string barriers, reported 140 cases (92%), where they rated the chilli-strings effective (average, to a greater extend or totally effective) in repelling the approaching animals, predominantly elephant. Only in 5 cases (3%) did they consider the technology to be noneffective.

Table 8: community perceptions on the effectiveness of the chilli-string barriers

Opinion on effectiveness of the chili barrier	Freq.	Percent
Totally effective	69	45.7
To a greater extend	54	35.8
Average (50-50)	17	11.3
To a lesser extend	6	4
Not at all	5	3.31
Total	151	100

#### KoboCollect data summary:

Direct observation - 73 chilli-strings interactions (from 82 set positions); noting that some of strings demonstrated multiple visits providing 176 observations of which 93 recordings indicated no direct sign of activity.

+ Indirect observations- 151 indications of wild animal response drawn from community perception guarding their crops (151 from 35 of the 82 positions = 431% increase?), less the 73 direct observations (151 – 73) = 78 additional deviations from the 82 possible strings positions (94%), that must have diverted well before them!

Community scouts perception, 140 from 151 observations were considered effective (93%); 11 were questionable (7%) – 6 didn't know and only 5 were considered a failure.

For elephant, a total of 31 from 33 barriers were visited (97%), indicating that they were dramatically repelled, the remaining 2 moving away although less alarmed!

These results for Mbire RDC indicate positive repellence provided by the chilli-string strategy, that is replicated every time on demand, providing proof for the technique, requiring much less effort to set up and replicate, effective for the entire season.

## **Data collation discussion, adding additional trialling results from elsewhere to establish the effectiveness of the chilli-string intervention:**

*A summary of data collated, recorded on the KoboCollect platform in Mbire Communal Land over two crop seasons 2019/20 and 2020/21, placing chilli-string strategically ambushing approach pathways set well before crop clusters. While much of the data collected was anecdotal, considered collectively, they serve convincingly to prove the efficiency of the strategy to repel depredate elephant*

Number of interaction activities observed was 176 from 82 set chilli-string positions spread over 8 of 17 Wards comprising the Mbire RDC in Zimbabwe, covering the area cultivated by communities. The 82 chilli-strings set providing 176 observations, 78 of them indicating direct animal response to the chilli-strings placed, some sites experiencing multiple visits by several herds, and from other species.

Of the chilli-string sets specifically targeting problem species: elephant were recorded at 53% (33 from 62) expected encounters; hippo 85% (23 of 27); hyena 21% (10 of 47); kudu 83% (5 from 6). Interestingly the 3 observations of buffalo sign at the strings were always those frequented by elephant.

A total of 74 responses were recorded at the chilli-string positions, all of which significantly repelled approaching animals from them. Contrastingly, there was no direct sign noted by bushpig or baboon, although it may be argued for bushpig, that many may have diverted well before the string positions as was observed with elephant.

Avoidance by elephant was characterised by direct aggression at the string sites, that included trampling of vegetation; digging up of the ground; pulling down of branches; trumpeting; running back or diverting away. KoboCollect recording direct vocalisation in 10% of the activities recorded, heard by the crop guards emanating from the direction of the strings. With respect to the remaining 3 visitations by elephant that appeared to have crossed the strings unsuspectingly, possibly owing to a prevailing tail wind, all 3 immediately diverted from their intended direction of travel, away from the protected crops; 2 running off, the remaining one walking away. Significantly, no elephant continued on to the crops.

Interestingly, over the same period monitoring the chilli-string sites, daily occurrence data recorded directly from communities actively guarding their crops, alerted to emanant elephant intrusion, reported 151 potential approaches coming from the direction of the strings; 140 of which never reached the lands (92%); 6 cases were questionable (5%); and in only 5 cases (3%), did they believe the strings were ineffective in deterring their approach. This infers that many of the chilli-string observations that did not indicate direct evidence of activity, may in fact have effectively deterred animals well before them. Information gleaned from monitoring satellite collared elephant near Victoria Falls indicated elephant can be deterred as far as 400-500 metres before the chilli-string positions under favourable wind conditions, positively deviating from their intended course of mischief. This observation provides possible explanation for the apparent discrepancy comparing the 33 direct elephant activities recorded at the chilli-string sites as compared with the 140 reported cases of repellence recorded by the targeted communities guarding their lands, as being those diverted away, well before the string positions, deviating unnoticed!

## Discussion: adding observations from other trialling opportunities

In Masoka (Ward11), at the commencement of the Mbire implementation trialling process recorded on KoboCollect platform, the principle intrusive pathway corridor emanating from Chewore South National Park PA, crossing the Angwa River boundary with Mbire RDC was selected for the first Chilli-string trial in Mbire that had been nightly frequented by several elephant that was effectively terminated on the *first* night the chilli-strings were placed, spoor of elephant bulls and cow herds consistently turning back, deviating some 50 metres before the string positions, recorded in table 9

<b>Night 26<sup>th</sup> November Tuesday</b>	<b>Large group of elephant approached within 200 metres before deviating to the East upon scenting the string</b>
<b>27<sup>th</sup></b>	<b>Herd approached the chilli-string and doubled back running</b>
<b>28<sup>th</sup></b>	<b>No elephant approached and no elephants entered the crops</b>
<b>29<sup>th</sup></b>	<b>ditto</b>
<b>30<sup>th</sup></b>	<b>ditto</b>
<b>1<sup>st</sup> December</b>	<b>ditto</b>
<b>2<sup>nd</sup></b>	<b>ditto</b>
<b>3<sup>rd</sup></b>	<b>± 15 approach and deviated to the hunting area to the East</b>
<b>4<sup>th</sup></b>	<b>No elephant came – Placed new chilli-strings at a separate corridor and no elephant approached</b>
<b>5<sup>th</sup> Dec- 13<sup>th</sup> Jan 2020</b>	<b><u>39 days since</u>, no challenges to the chilli-string including 3 new sets set in last week, that also have not been challenged indicating total repellence success to date!</b>
<b>Since – 23<sup>rd</sup> Feb 2020</b>	<b>Approach paths totally abandoned – no recent activity noted at all</b>
<b>Elsewhere in Mbire RDC</b>	<b>Communities on their own have replicated these measures for their respective Wards that has resulted in elephant clumping, possible preparation to vacate Mbire completely!</b>
	<b>Elephant reported to have withdrawn to the campfire hunting areas out of cultivated areas</b>

Table 9 table reproduced from my AWF training report dated Dec 2019 reporting elephant activity Masoka Ward 11 in Mbire

**Table 9:** daily reporting of elephant activity In Masoka Ward blocking the principle pathway into the Masoka Community indicated immediate results that completely terminated all elephant passage ever since - to date of writing (August 2021), lasting three years despite the strings no longer being placed

Community buy-in to the technique recorded more than 100 individual farmers in Mbire last season (2020/21) requesting string and chilli pepper following these results, happy to apply the technology themselves – a situation I have never recorded before in 50 years of HWC operations, except for a few isolated individual farmers. This request was also noted for Ward 7 of Tsholotsho RDC, in Mozambique, and more recently in the Binga and Hurungwe Districts of Zimbabwe.

Perhaps the greatest argument for the effectiveness of the strategy has to be the total turnaround of community perception from being completely negative, suspicious of NGO

activity, radically reversing their perception in one season, becoming positive and supportive, willing to implement the intervention on their own prompting my reanalysis of the apparent anomaly recorded on KoboCollect, comparing the results reflected in table 2, 43% (78) to observations of repellence achieved reported by the 140 reports of success provided by the community protecting their crops reported in table 8 that indicated effective repellence against expected intrusion heard from animals in the direction the chilli-strings placements

***Evidence for protracted protection!*** Later monitoring of the Mbire situation has indicated further advantages of the chilli-string technology recorded the year following the 2019/20 season, despite the chilli-string positions largely becoming defunct, where elephants even, resumed moving through some of the previous string positions, but continued to avoid the crops beyond, possibly because of their newly established remembered conflict avoidance they recently learned there. Questioning communities more recently in September 2021, they reported 2 chilli-string positions still indicating direct avoidance, including the Masoka report detailed above. At a further position where elephant had commenced passage through, simply replacing a string stopped further passage

This observation was also noted at the Vic Falls dump site, that had been effectively protected employing the chilli-string approach for 3 years, elephant still avoiding the dump site despite the chilli-string positions not being maintained beyond the first month. Recent reports indicating still less incursions after the 2016 placement of the chilli-strings, current invasions thought rather to be detractors residing immediately around the dump site rather than elephant coming in from elsewhere.

***First history that lead to the discovery of the chilli-string phenomenon:***

The chilli-string concept was first realised in Ward 7 of Tsholotsho RDC, implementing a WWF community project where the protocol required HWC mitigation over a short 2km length of crop land abutting the community wildlife and grazing area. The limits set were determined by available funding at the time, concentrating on the borehole 27 Pelendaba corner road where most intrusions by PAC elephant occurred. To prevent bias choosing specific fields, I was tasked to develop an approach to protect whole crop clusters. My thinking at the time, was to provide several layers of interventions set in a staggered format, reasoning that should problem animals navigate through some of them, they would invariably bump into others following; but collectively the interventions, I was hoping, would provide for a virtual boundary effect. Results were phenomenal, unexpected; elephants over 4 seasons failing to pass even the first line of intervention placed. Analysing these results indicated to me that it was not so much the objects placed that were avoided, but rather the positioning of them; the place where it happened being more important. More surprising was that the whole interface between the wildlife area and crops along the western edge was avoided for a distance of 22km, that can only be explained considering the concept as an entire unbroken interface that had been established as the remembered conflict zone in the mindset of elephant, that I refer to as an SVB (Soft Virtual Boundary). Later trialling universally indicated that the results were the same whether old engine oil, creosote or chilli pepper was employed as the primary scent repellent agent, so long as it was foreign to elephant and provided that there had been direct conflict repellence in the past in the lands ahead!

Results for the entire cropping period Dec to July 2016 in Ward 7 of Tsholotsho were that no elephant penetrated the interventions, or Ward 7 despite the fact that an estimated 250-500

elephant had moved in nearby and resided within 200 metres of the virtual fence created, during the months April to May (the main crop growing period). On several occasions spoor indicated they approached the barriers on several evenings but had doubled back when they saw/smelt the various interventions placed.

Only 3 lands were damaged in Ward 7 that year, inflicting less than USD 1 000 damage, none of which were adjacent to the protected area, and no elephant were shot on PAC for the entire Ward because of minimal elephant intrusion experienced for the whole of ward 7 I believe. This contrasted starkly to the previous season where most of crops were ravaged; 150 cropped lands completely destroyed at an estimated loss of USD 22 000.00 resulting in the shooting of 14 PAC elephants in Ward 7, 6 of them opposite the 2km zone specifically protected.

Additional indicators for effective repellence in Tsholotsho were:

- Total 100% community buy in to the success despite being dubious at first
- Community negative perception completely reversed to currently positive support
- Community willingness to extend the interventions on their own to complete the protocol
- Confidence reported by the Ward 7 community for each of the individual component tools employed, that included:
  - Ambushing the approach paths, noting elephant regularly turning back from them
  - Employing chilli string ACE positions – direct repellence noted from the first component string positions as indicated from ground sign
  - The same noted for the pole barriers even when lying on the ground prior to erection
  - Reflective bottles – directly for elephant and employed to surround a melon field in the trial area that totally repelling kudu from entering
  - Mhiripiribomba – the chilli guns were successfully employed on 7 separate occasions in Ward 7 against depredating elephant, one of which involved 8 bulls in the trial area, *that came in from north* of the protected area on the opposite side of the intervention positions, that then found themselves trapped within the Ward that were effectively chased out by the using the mhiripiribomba chilli-guns. The remaining 6 occasions, elsewhere along the Eastern edge of Ward 7, again the opposite side to the interventions; where again the elephant were confidently evicted each time employing the mhiripiribomba.

From these observations, and earlier unexplained occurrences during my capture and PAC management years, never understood at the time, I realised I had in fact stumbled on a virtual fence dynamic to mitigate HWC that may be replicated as follows:

- More effective than physical repellence options, was a virtual application of them that provided:
  - Better long term repellence, recent indications being for the whole cropping season, perhaps even longer
  - Defends whole clusters rather than individual lands.
  - Active for the whole unbroken SVB.
  - Hugely reduced effort to administer.
  - Effective for other species – hippo, buffalo, kudu, and hyena.
  - Enhances accompanying physical interventions, combining well.
  - Although unintended, because of its effectiveness it is mostly being implemented as a standalone tool.
  - An intervention that was easily and quickly moved positionally to deliberately confuse elephant further should this be necessary.
  - Seeing is believing, a concept quickly adopted by communities.
  - More recently observed: indications are that avoidance may be perpetuated, elephant positionally remembering virtual conflict avoidance, continuing to avoid previously protected crops.
  - indicating a strong potential for the concept to provide for an effective teaching aid, to reverse habituated tendencies.
  - The concept maybe replicated on demand providing scientific verification.
- Most importantly, it was not the object itself that was avoided as when employing physical barriers, but rather the position of them that is avoided; hugely elevating suspicion going forward that they avoid.
- Requires an understanding of animal behaviour mitigated against, in particular moving from a daily place of refuge, accessing pathways directly to the chosen place of mischief, the crop clusters chosen, understanding that:
  - Places of refuge are sought by persecuted depredating animals each day.
  - Ambushing approach pathways within the safe areas they access, that includes PAs, riverine vegetation, thickets, communal wildlife, and grazing areas **outside** cultivated areas (*habituated zone*), that animals prefer to access through.
  - Elephant are creatures of habit that know their home range precisely avoiding the unknown, that is registered precisely against season and place, added to their general remembered knowledge.
  - Knowledge gained through habituation and exposure taking  $\pm 2$  years to become established with respect to opportunities, far less for conflict that is often immediate, pending severity.
  - Elevated suspicion always overriding intended *purposed travel*.
  - Animals always opting for the 'safe' pathways of approach to the crops they depredate.
  - Understanding:
    - *That purposed travel* is the route they routinely take to the place of intended mischief.
    - The importance of avoiding the *habituated zone*.
    - Understanding SVBs, identifying and managing them.
- The few situations where the concept didn't appear to work were either where:

- The chilli-string was placed in the *habituated zone* around human development, including crops and dwellings – that must always be placed to the outside of these in the less risky approach zone where the intruding animals have previously had no history of direct challenges taken against them
- Or! Where there has been no previous history of conflict to the elephant in the lands they depredate as occurred in Hurungwe, (Ward 7), remembering that the chilli-string position serves to pre-alert them of pending danger ahead, that they know and recognise.
- More recently in Ward 3 of Tsholotsho, cropped lands hard against Hwange National Park, provided a problem that negated chilli-string intervention effectiveness operating there, being inside the risk boundary (SVB) interface, inside the habituated zone that negated its virtual application. Similar problems recently experienced in Hurungwe RDC (Ward 7), were corrected placing the strings well inside the PA boundary that worked, effectively, warning approaching animals with intent to crop raid. The measure in effect providing a virtual buffer zone within the Park boundary without compromising PA integrity, an idea we also intend following up for rhino moving out of PAs into neighbouring communities

These observations are consistent, providing the hypothesis that a piece of contaminated string with a foreign odour is sufficient to completely repel elephant for the whole season provided that it is strategically placed, ambushing the principle paths approaching crops, even a kilometre distant, and provided it is placed ***outside the habituated zone***; effective for the immediate season, even longer once the virtual mindset has been realised. *La Grange 2019*. Provided too, that there has been remembered conflict in the crops they have purposed to raid. Noting that the absence of conflict within the lands, completely negates this virtual phenomenon!

***Scientific verification of the hypothesis established:***

The validity of this hypothesis has been established, replicating the concept on demand, 2019-2021 through 2 cropping seasons and at the Victoria Falls dump site; The Mbire community; LNP in Mozambique; crops in and around the Maputo Special Reserve; Chimanimani District in Mozambique; more recently the Kariangwe and Lesulu Wards in the Binga District and finally, other isolated cases protecting lodge complexes as implemented on Spurwing Island, Kariba. (see attached attributes and observations the technology effectively provides).

***Suggested combinations to apply this technology:***

While the technique is effective as a standalone repellent intervention, nevertheless I still advocate it should be combined with other interventions to maximise effectiveness that includes an early warning fence equipped with warning bells and reflective bottles fortified with mobile smouldering chilli briquettes placed in braziers around the lands. Finally within the lands if required, directly evicting any that have broken through employing the mhiripiribomba chilli-gun. This combination proving to be a highly effective, providing three layers of intervention should the chilli-string interventions ever become challenged.

**Footnote:** Recent observations are indicating the mhiripiribomba chilli-gun value adds considerably to the mitigation process, closely mimicking the PAC hunting of elephant, providing sufficient fright to detractors (except possibly the most habituated individuals), enabling virtual entry prevention to the cropped lands ahead. The mhiripiribomba effectively serves to 'arm' the chilli-string ambush position set across the approach pathways to access crops, pre-alerting elephant significantly, elevating suspicion and conflict remembrance going forward that completely terminates *purposed travel*, avoiding all human activity ahead.

Interestingly because it is not the object employed that fosters avoidance but rather the strategic position of it that establishes the virtual mindset reality, meaning that any foreign object serves the same purpose, whether it is pole barrier, chilli-string or burning chilli-brick brazier or even a bee fence. Effectiveness remains the same, whether chilli-oil, creosote or old engine oil is employed as the primary scent agent, provided it is foreign!

Finally, it must be always borne in mind, that chilli-string barrier interventions are not physical fences, but simply a virtual ruse of them, that provides better avoidance benefit, harnessing the virtual mindset of 'elevated suspicion', effective against any human activity ahead, providing greater repellence over longer periods (possibly even perpetually), in some instances than does physical applications.

**References:**

**La Grange M. 2019:** Virtual boundaries, the unseen mechanism governing all movement and behaviour of wild animals that enables the smart management of wildlife ISBN 978-613-9-44285-0 LAP LAMBERT academic publishing Mauritius distributed by More Books Denmark

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