India Vulture Repopulation BOTEC v0.6 (Sept 2026)

Note: BOTEC conventions are to try and find interventions costing under $3,000-$5,000 per death prevented (Coefficient Giving & ~GiveWell) . 1,000x is ~$3,000 bar, so 500x is half as cost-effective (~$6,000/death) and 2,000x is twice as cost-effective (~$1,500/death)

~$11,150/death (~270x)

Bring Back India's Vultures (Repopulation)

The program must remove diclofenac and other NSAIDS fatal to vultures, as well as rebuild their population. Nepal-model diclofenac ban enforcement is needed in India (undercover pharmacy surveys, district declarations, free meloxicam, safe-zone expansion). This BOTEC is for India only. Pakistan, Bangladesh, Ethiopia and Guinea-Bissau were modelled and all landed far below the bar, so they were dropped.

Back of the Envelope Calculation:

Validity multiplier on F&S's 104k/yr: 0.25 (0.1–0.45). Anomalous single-study effects are known to shrink when replicated. Replication base rates leave ~0.2–0.4 of the headline. Most of the health impact comes from weakly-measured waterborne diseases. Therefore I'm lowering India's excess death estimate to ~26,000 at the 2000–05 peak.

Attenuation to 2026: 0.30 (0.20–0.45).
Disease exposure: 0.45–0.80 left from the 2000-2005 collapse. Piped water and sanitation gains occurred, and the open-carrion stream is probably the same. (possibly worsened since the flaying economy collapsed in 2017).
x
Treatment: 0.35–0.50 remaining from the 2000-2005 collapse. Diarrhoeal case fatality is down 50–65% via dehydration treatments and rotavirus vaccines.

Recoverable deaths/yr today (D0): 7,800. India's ~307M bovines shed ~27.6M natural-death carcasses/yr (Frank and Sudarshan rough guess, Appendix A10). These are dumped near settlements and unsanitised. Peak rate of ~0.00094 deaths per open carcass, which is attenuating at ~5% a year (Decay) left for vultures to "recover." Each year brings it closer to a residual floor (Residual floor).

Residual floor: 0.10 of D0 (0.03–0.25). The top crux in this calculation. Carcass-attributable mortality never completely reaches zero. This accounts for the poorest districts, shallow wells,

and undisposed carrion. Because the vulture's carrion disposal service arrives ~54 years out, most all the value accrues at this floor rather than at today's 7,800 deaths/year. (D0)

Decay of the problem: 4.75%/yr (3–6.5%). Water, sanitation and case management keep improving regardless of vultures, so the prize shrinks while the birds breed. Applied year-by-year to a rising benefit stream.

Years to the 30% functional threshold: 54 (40–80). Vulture populations are at ~1% (0.2–2%) of baseline and are not recovering. Nepal's +12.7%/yr with 95–96% survival is the ceiling; this cell uses 8% with a 10-year early-generation lag, because ~16% of sampled carcasses still carry toxic NSAIDs against a 0.01–0.1% tolerance, and enforcement will not be perfect from day one.

P(program delivers the trajectory): 0.4 (0.25–0.6). Nepal shows recovery works where the environment is genuinely diclofenac free. The binding constraint is sustaining enforcement for four decades. India has already banned four NSAIDs resulting in zero vulture recovery, and other poisonous NSAIDs also come to market.

Credit share: 0.8 (0.5–0.9). We would fund the incremental program. Small discount for institutional infrastructure that already exists and would work on this regardless of any of our funding.

Arithmetic: 26,600 deaths averted over 80 yrs × 0.4 × 0.8 ≈ **8,500 expected**. Cost $95M ($15M over the first five years for enforcement, monitoring and safe zones, then ~$2M/yr for 40 yrs) → **~$11,150/death, ~270x**. Not close to being a highly cost effective life-saving intervention.

No Recommended Actions

Notes

Verdict-flipping cells: none. Widest swings: residual floor (0.03/0.25 → ~167x/~610x), validity (0.10/0.45 → ~108x/~484x), cost (×1.5/×0.5 → ~179x/~538x), then P(success) and growth rate.

The vultures recover after the problem has gone away: The service arrives ~54 years out, after WASH and health-system progress shrink the health decline ~4.75%/yr to a residual baseline. Prevention value is front-loaded, restoration value is back-loaded into a world that has essentially solved the problem by other means.

Correlated cells. Floor, decay and P(success) all track development speed: faster growth in India shrinks the prize (higher decay, lower floor) while making enforcement easier. The offsets stabilise each other, which is why the verdict is firmer than individual cells.

Companion chain. Chain D (CRISPR diclofenac resistance, next tab) attempts the same outcome with a different method and comes out at ~2.5x — inferior to this chain in every cell.

Drafted by Claude for Jackson/Tandena, Sept 2026

CRISPR Vulture BOTEC v0.6 (Sept 2026)

Not Recommended

Conventions: 30 cDALYs/death, $100k/DALY, CG bar ≈ 2,000x ($1,500/death), GiveWell-top ≈ 1,000x ($3,000/death). Costs are full-program and undiscounted. Same D0 chain as Chain C (restoration, previous tab), so the two routes are directly comparable.

~$130,000/death (~23x) with permission assumed away; ~$1.2M/death (~2.5x) if the program must win it. Misses the bar by 90–800x
Suggested method: none, for vultures. If the germline platform is built, build it for a species whose generation time lets the benefit arrive while the problem still exists.

Chain D — CRISPR diclofenac resistance

Two scenarios: **C1** = permission to release a GM bird is assumed away; **C2** = the program must win it. India, Pakistan and Bangladesh only. Africa is excluded because its vultures die of carbamate baiting (~61% of recorded deaths) and belief-based trade (~29%), neither of which a diclofenac-tolerance edit touches.

What the edit actually buys: susceptible excess mortality 9.8%/yr → 0. Calibrated so the unedited counterfactual grows ~1%/yr (matching India's observed non-recovery) and the edited population at Nepal's 12.7% ceiling. That is the entire mechanism. The edit does not change one egg per year, first breeding at 5–7 years, or the 30% functional threshold.

Time to first release: 17 yrs (12–25), plus 8 more in C2. Five years to build primordial-germ-cell culture and surrogate hosts for a raptor (never attempted; a chicken cannot carry vulture germ cells, so a captive vulture surrogate colony is required), seven for an edited founder to reach sexual maturity, five to breed and verify a heritable, protective line. Every verification step costs a generation.

Spread: Mendelian under selection, no gene drive. India 50 yrs post-release to 50% allele frequency; Bangladesh 18. CRISPR homing drives have never worked in any vertebrate — the mouse attempts cut the target but showed no detectable homing. Selection is strong (~10%/yr against susceptibles) but compounds from ~zero: 40 released birds/yr is 0.2% of India's 20,000 wild birds versus 4% of Bangladesh's 260.

P(platform works in a Gyps vulture): 0.5 (0.25–0.75). Long-term PGC culture is a chicken achievement and the conditions are species-specific; sterile surrogate hosts exist only in

chicken. Extension to other birds is early and no raptor has been attempted. Failure here is a total loss of the $25M platform spend, with no partial credit.

P(edit confers real protection): 0.5 (0.2–0.9). The target is unusually clean: a premature stop codon in intron 7 of the CYP2C19 ORF, conserved across eight unrelated vultures. But the same paper notes residues 105, 286 and 289 would leave the repaired enzyme weaker than the human one, and toxicity may not be wholly CYP2C19-mediated, so a one-codon fix may buy only partial protection.

P(50-year program sustained): 0.7. Longer than any conservation program currently running, spanning several funder generations and at least two political cycles per range state. Pinjore — the only colony large enough to build a line from — already describes its funding as a severe crunch and is releasing birds partly to cut costs.

P(GM wildlife release approved): 1.0 in C1 by assumption / 0.30 (0.15–0.5) in C2. Anchor: Darling 54, the blight-tolerant American chestnut and the closest available analogue (a first-of-kind GM organism restoring a lost trait), was petitioned in Jan 2020; USDA finished review in Jun 2025, no final decision by 2026, EPA review still multi-phase, and its own sponsor withdrew support in 2023. That is the most permissive jurisdiction on earth, for a plant.

Credit share: 0.8. Cost $129M (C1) / $155M (C2), India. As Chain C, the program rides on existing captive colonies, the avian-PGC literature and the SAVE network. Cost is $25M one-time platform plus $2M/yr for ~52 years of colony, releases and monitoring, plus $10M for the regulatory campaign in C2.

Arithmetic (India): P(success) = 0.5 × 0.5 × 0.7 = 0.175 (C1); ×0.30 = 0.053 (C2). C1: 7,100 deaths averted over 80 yrs × 0.175 × 0.8 = 995 expected; cost $129M → ~$130,000/death, **~23x**. C2: 3,080 × 0.053 × 0.8 = 129; cost $155M → ~$1.2M/death, **~2.5x**. Breakeven P(success) is 15 and 42 — impossible at any probability.

Notes

Verdict-flipping cells: none. Unusually for these models, no cell flips the verdict at its range edge. The widest swings are the residual floor (0.03/0.25 → ~9x/~57x), release rate (15/120 birds a year → ~10x/~43x), clean growth (8%/13% → ~4x/~30x) and time to first release (25/12 yrs → ~10x/~34x). The all-optimistic trajectory corner is ~146x, still 14x short.

Dominated, not merely worse. The edit costs more than restoration, delivers the service 25–30 years later, and has a lower probability of working — while buying exactly the clean-environment growth rate Nepal already bought with undercover pharmacy surveys,

district declarations and free meloxicam. It is a substitute for enforcement, not for vulture biology.

Horizon doesn't rescue it. Extending benefits from 80 to 150 years gives ~146x; the all-optimistic trajectory corner gives ~146x; both together ~490x. C2 at 150 years is ~32x. The conclusion is insensitive to the one accounting choice that most favours a back-loaded intervention.

Where the genetics works is not where the value is. Bangladesh is the best place to run the biology (releases ~4% of the wild population, threshold ~2,600 birds, allele at 50% in 18 years, threshold reached year 42) and the worst place to run it for health (~60 recoverable deaths/yr). India holds essentially all the value and is the slowest case. Develop on India's captive stock, demonstrate in Bangladesh.

The platform, not the vultures, is the case worth arguing. Framed as a breakeven rather than scored: the $25M germline platform pays for itself if it later enables interventions worth ~16,700 deaths averted, about two years of India's entire recoverable burden. What kills the vulture case is generation time, not editing — a species first breeding at 1–2 years with a clutch of 2–4 compresses the same 50–90 year arc into 10–20.

Species coverage is narrower than it looks. ~16 Old World vulture species presumably share the CYP2C19 defect (it was conserved across eight unrelated birds), but only the three South Asian Gyps have NSAIDs as their binding threat. Africa's five big species are poisoned deliberately; Europe's share the defect but not the exposure, since fallen stock is collected and rendered. Each additional species needs its own PGC line and colony.

Uncosted upside. Extinction insurance for three Critically Endangered species, permanent immunity if NSAID enforcement fails later, and the platform option value above — the strongest honest argument for the spend, and not a health one. Excluded here, as conservation co-benefits were in v0.5.

Actions:

No Recommended Actions

Drafted by Claude for Jackson/Tandena, Sept 2026

Diclofenac Prevention Vulture BOTEC v0.5 (Sept 2026)

Conventions: 30 cDALYs/death, $100k/DALY, CG bar ≈ 2,000x ($1,500/death), GiveWell-top ≈ 1,000x ($3,000/death).

~~~~$1,550 per death averted, ~2,000x central (~$50–$280,000 corners) — at the CG bar. Suggested method: Lobby for a PARAN ban on diclofenac (and related NSAIDs) across Africa by late 2027.~~~~
17x in expectation

Chain B — Africa pre-emptive NSAID regulation

Validity multiplier on F&S's 104k/yr: 0.25 (0.1–0.45). Anomalous single-study effects shrink: replication base rates leave ~0.2–0.4 of the headline. India's rabies budget (≤ ~20k/yr) means the rest rides on the weakly-measured water channel. Therefore I estimate ~26,000 excess deaths/yr.

P(counterfactual NSAID crash, 20 yrs): 0.20 (0.05–0.40). Prior-dominated. The threshold for vulture collapse is low (~1% of accessible carcasses), so the cell describes a race: treatment share rising with dairy intensification, accessible-carcass share falling with salvage-slaughter and disposal, total carcasses rising. So far we know they are undergoing a slow decline, not a crash. (Spontaneous regulatory/NGO interception also lives in this cell.)

~~**Expected service fraction persisting: 0.45 (0.30–0.65).** Africa's vultures have already thinned. Populations are concentrated in protected areas away from exposed people while the urban-working species decline fastest. 3–6%/yr attrition continuing through the window. ≈ current service-weighted fraction (~0.55) × forward decay (~0.8).~~

~~**Transport: 0.14 ≈ 0.40 intensity × 0.35 exposed-population (0.06–0.25).** India's death toll came from dense populations living beside concentrated whole-carcass dumps; Africa has far fewer people per carcass and far fewer whole carcasses — the dose doesn't transport. The treated, whole, near-people carcass stream (India's configuration) is several-fold thinner. ~3,600 deaths/yr if crash.~~

Effective damage-years: 13 (9–18). Water, sanitation, and case management improve ~4.5–5%/yr regardless of vultures, so each later crash-year kills fewer people. 25–30 calendar years of crash compress to ~13 full-strength years.
~~~~

ΔP(campaign prevents | coming): 0.55 (0.4–0.7). Blocking registration before a market exists is far easier than removing an entrenched drug (price-parity substitute exists, one PARAN insertion covers many countries).

Credit share: 0.75 (0.5–0.9). This intervention hasn't been made thusfar. ~$3–8M/yr global niche; small discount for the NGO infrastructure the campaign rides.

~~**Arithmetic:** E[deaths averted] = 0.20 × 0.45 × 3,600/yr × 13 × 0.55 × 0.75 ≈ ~1,750. Cost $2.7M ($1.7–4.7M); minimal core $1.2M. → ~$1,550/death, ~2,000x central; pessimistic corner ~$280k/death (fails hard); minimal core ~2x better per dollar. Health channel only — conservation insurance for 6+ threatened species rides free.~~
17x

Notes

Verdict-flipping cells. Three cells each flip the verdict alone at their range edge: P(crash) → 0.05 (~$6,200/death), validity → 0.1 (~$3,900), transport → 0.06 (~$3,600). Information gathering would narrow them via pharmacy surveys, rerunning the original paper, and field data on disease point-sources.

Correlated cells. P(crash), persistence, transport, and damage-years are all shaped by development-speed: faster intensification raises crash probability (drug penetration) while lowering persistence (conflict poisoning) and damage-years (WASH, case management). The offsets makes them stable.

Timing asymmetry. The value of registration-blocking is front-loaded — each year of delay converts the easy problem (keep it out) into recovery and disease mitigation which is much harder and more costly.

Actions:

PARAN diclofenac ban ($450k, window ~late 2027)

Drafted by Claude for Jackson/Tandena, Sept 2026

Diclofenac Prevention Vulture BOTEC v0.5 — Synthesis (worksheet format)

Conventions: 30 cDALYs/death, $100k/DALY, CG bar ≈ 2,000x ($1,500/death), GiveWell-top ≈ 1,000x ($3,000/death). One justification per cell: the factor that drives the number.

Part 0 — The causal chain

Dollars fund an experienced conservation-policy org to insert vulture-safety NSAID restrictions into African veterinary-drug regulation — primarily via the PARAN-VPs harmonized guidelines (window ~late 2027; one insertion covers many countries). If toxic NSAIDs were otherwise going to penetrate African livestock markets and crash vultures, registration-blocking intercepts them before entrenchment; vultures keep scavenging; the India-style sanitation shock (water contamination, flies, dogs/rabies) does not happen.

Part 1 — The India anchor

1a. Published claim (given): F&S (AER 2024): ~104,386 excess deaths/yr at the 2000–05 equilibrium.

1b. Validity multiplier: 0.25 (0.1–0.45) — Confidence: Med

- Driver: surprising single-study effects shrink — replication base rates leave ~0.2–0.4 of the headline, and India's rabies budget (≤ ~20k/yr) means the rest rides on the weakly-measured water channel.
- Moves it: I1 re-run ($20k) — now the sole live discriminator: the Sept-17 sibling-bound audit corrected the Pakistan/Nepal detection floor to ~4–5% all-cause (spike-shaped effects unconstrained), so those nulls no longer weigh against F&S.
- → Posterior peak: ~26,000 excess deaths/yr (10–40k).

1c. Why India restoration fails as a health intervention (one line each): validity (believable benefit ≈ ¼ of headline); attenuation (rabies −71%, WASH much improved — only ×0.2–0.45 of the harm remains to recover); demography (6-yr doubling puts service recovery 30–80 yrs out); enforcement (four bans since 2006, rampant illicit use, zero recovery).

Part 2 — The Africa prevention chain

Scenario: ~$2.7M ($1.7–4.7M) advocacy campaign; minimal core $1.2M.

Cell A — P(counterfactual crash): 0.20 (0.05–0.40) — Confidence: Low

- Driver: prior-dominated — use has never been measured (no African pharmacy survey exists; the availability evidence is one 2007 marketing episode). The threshold is low (~1% of accessible carcasses sufficed in India, which ran ~10x that), so the cell prices a race: treatment share rising with dairy intensification, accessible-carcass share falling with salvage-slaughter and disposal, total carcasses rising. Decline forensics (slow, guild-wide, pesticide-confirmed) rule out an Indian-scale kill underway now, not a slow bleed; slow-bleed worlds carry partial weight (likelier, less damaging per year). A crash also requires the treated∩accessible overlap, and salvage-slaughter economics decouple the two: vultures do feed on livestock at scale (the poisoning record proves it), but the animals worth treating are the ones butchered when they fail, so the carcasses that reach vultures are disproportionately untreated. India's crash required treated and accessible to coincide; intensification erodes the decoupling from both sides.
- Scope note: spontaneous regulatory/NGO interception (no campaign) lives here. E is our campaign's marginal effect; F is other funders running this same campaign.
- Moves it: I3 pharmacy surveys — the top information buy.

~~**Cell B — expected service fraction persisting: 0.45 (0.30–0.65)** — Confidence: Med~~

- ~~Driver: the transported deaths/yr assumes the intact service India lost, and Africa's has already thinned — survivors concentrate in protected areas away from exposed people while the urban-working species decline fastest — with 3–6%/yr attrition (carbamates, belief trade) continuing through the window. ≈ current service-weighted fraction (~0.55) × forward decay (~0.8).~~
- Moves it: poisoning-trend data; protected-area population trajectories.

Cell C — transport, bundled: 0.14 ≈ 0.40 per-capita intensity × 0.35 exposed-population (0.06–0.25) — Confidence: Low

- Driver: India's death toll came from dense populations beside concentrated whole-carcass dumps; Africa has far fewer people per carcass and far fewer whole carcasses — the hazard transports, the dose doesn't. This is not a claim that vultures lack access to livestock carrion; it's that the treated, whole, near-people carcass stream (India's configuration) is several-fold thinner.
- → Deaths/yr if crash: 26,000 × 0.14 ≈ **3,600/yr**.

- Moves it: mortality data around localized African vulture losses; carcass-practice surveys. (Sibling-bound audit: corrected floor ~4–5% all-cause — consistent with the full 0.06–0.25 range, constrains none of it.)

Cell D — effective damage-years: 13 (9–18) — Confidence: Med

- Driver: water, sanitation, and case management improve ~4.5–5%/yr regardless of vultures, so each later crash-year kills fewer people — 25–30 calendar years compress to ~13 full-strength years.
- Moves it: WASH / case-management trajectories in range states.

Cell E — ΔP(campaign prevents | coming): 0.55 (0.4–0.7) — Confidence: Med

- Driver: blocking registration before a market exists is far easier than removing an entrenched drug (price-parity substitute, PARAN venue) — but Spain shows even the easy case stalls about half the time.
- Moves it: PARAN-VPs process detail; who actually holds the pen.

Cell F — credit share: 0.75 (0.5–0.9) — Confidence: Med

- Driver: nobody else is funding this — the recommendation has sat unexecuted for years inside a ~$3–8M/yr global niche; small discount for the NGO infrastructure the campaign rides.
- Moves it: mapping who else would fund this within 5 years.

Arithmetic:

- E[deaths averted] = 0.20 × 0.45 × 3,600/yr × 13 × 0.55 × 0.75 ≈ **1,750**
- $/death averted = $2.7M ÷ 1,750 ≈ **$1,550** → **~2,000x** (corners: ~$50 optimistic, ~$280,000 pessimistic)
- Bar: CG ≈ $1,500/death (2,000x); GiveWell top ≈ $3,000–5,500/death.

Sanity checks:

- All-pessimistic corner ≈ $280,000/death — fails hard. The model can produce a bad answer.
- Three cells each flip the verdict alone at their range edge: A → 0.05 (~$6,200/death), validity → 0.1 (~$3,900), transport → 0.06 (~$3,600). All three are purchasable: I3, I1, I2/field data.
- Correlation note: A, B, C, D share a latent development-speed driver (faster development ⇒ higher A, lower B and D). The offsets make the bottom line more stable than any single cell.

Part 5 — Verdict

~~Pre-emptive NSAID regulation in Africa comes out at ~$1,550/death averted, ~2,000x on the health channel alone — at the CG bar, ~2x better than GiveWell top charities — sitting on one contested study and two nearly-empty evidence cells. Conservation co-benefits (four Critically Endangered species) ride free and are excluded. The action: ~$975k of information-buying plus the deadline-bound PARAN insertion before any scale funding. Weakest cells, in order: P(crash), validity, transport — each singly verdict flipping, each purchasable.~~

17x