

# TOOLS TO ENABLE BETTER PLANNING OF MASS DOG VACCINATION PROGRAMS

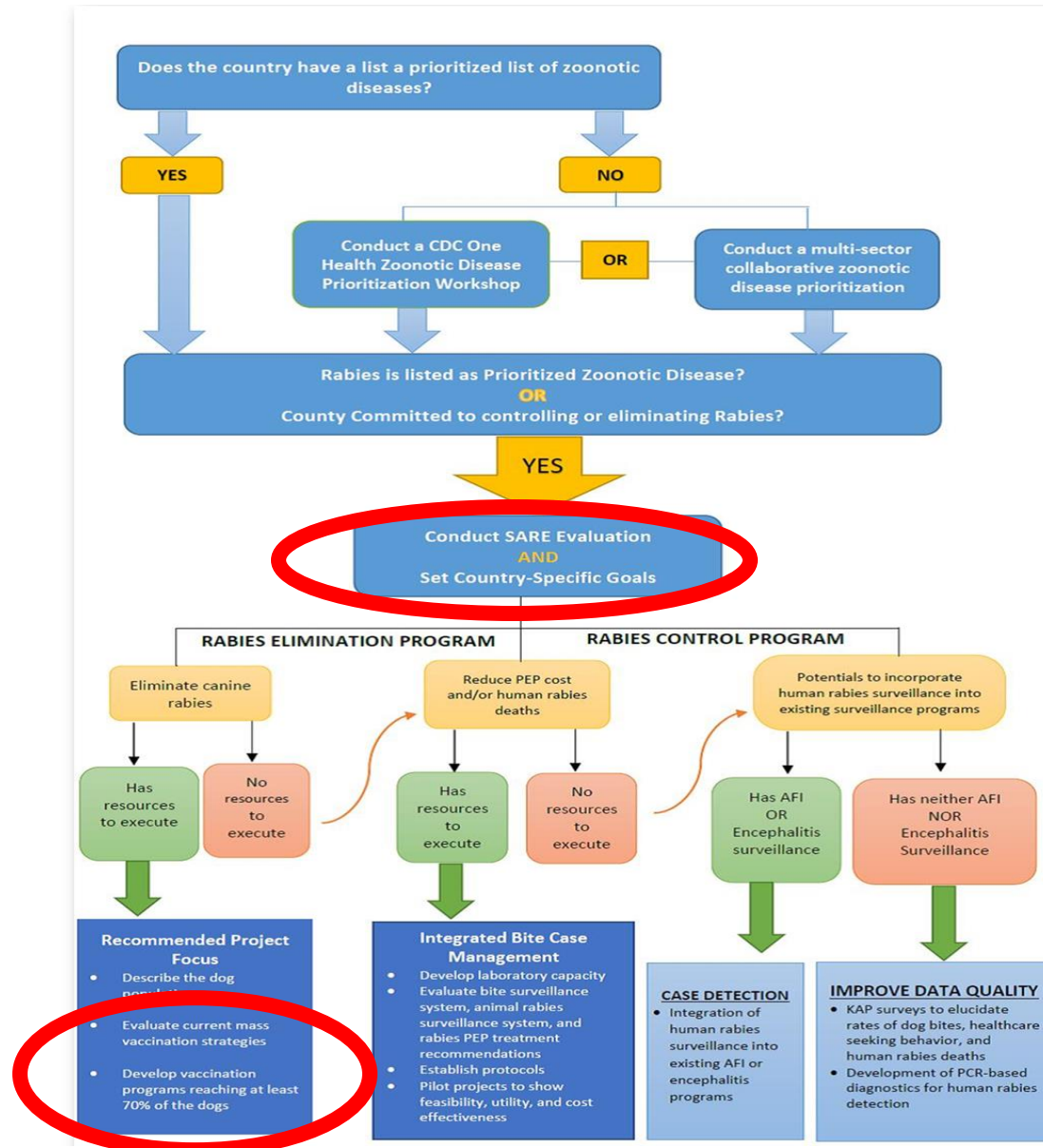


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**U.S. Centers for Disease Control and Prevention**

# CDC Decision Tree to Strategize Rabies Control





# Successful Elimination

- How many dogs do we have?
- How much vaccine will we need?
- How many vaccinators do we need?
- What infrastructure do we need?
- What advances do we need?



# Identifying global data sources

2015 COUNTRY  
POPULATION

HUMAN  
DEVELOPMENT  
INDEX

HUMAN:DOG  
RATIOS (Knobel)

DOG VACCINATION  
COVERAGE  
(Hampson)

OIE VETERINARY  
CAPACITY

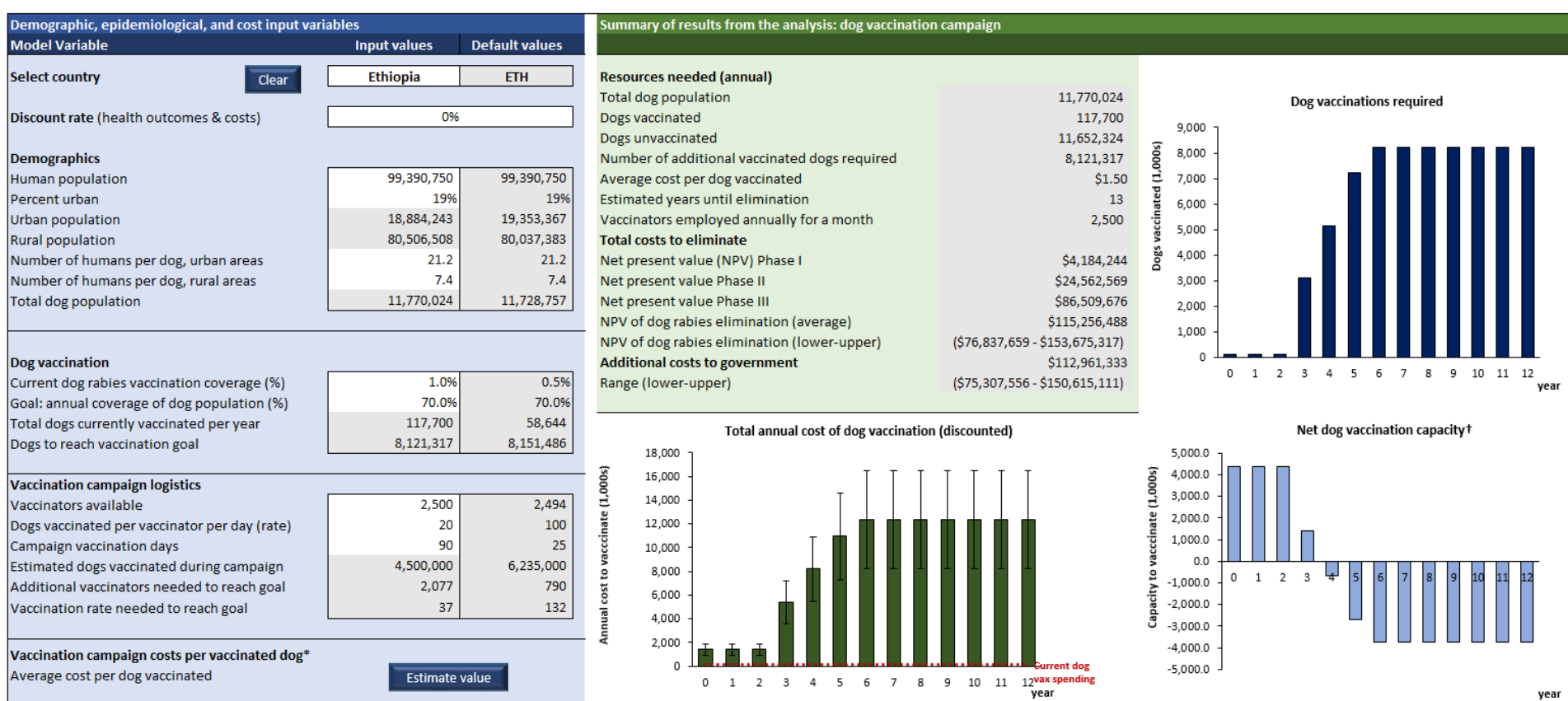
**DATABASE**

| Country                          | Continent | Cluster                  | World Bank Human Population | Percent Urban | Human Development Index | Canine Rabies Hamp | Canine Rabies | Entire Country Affected | Urban Population Affected | Rural Population Affected | Total Population Affected | Urban H:D Ratio (Data) | Rural H:D Ratio (Data) | Urban H:D Ratio (Known) |
|----------------------------------|-----------|--------------------------|-----------------------------|---------------|-------------------------|--------------------|---------------|-------------------------|---------------------------|---------------------------|---------------------------|------------------------|------------------------|-------------------------|
| Afghanistan                      | Asia      | Eurasia                  | 32,526,562                  | 26.703        | 0.398                   | 1                  |               |                         | 8,685,568                 | 23,840,994                |                           |                        |                        | 7.5                     |
| Albania                          | Europe    | EasternEurope            | 2,889,167                   | 57.407        | 0.739                   | 1                  |               |                         | 1,658,584                 | 1,230,583                 |                           |                        |                        | 6.5                     |
| Algeria                          | Africa    | North Africa             | 39,666,519                  | 70.727        | 0.698                   | 1                  |               |                         | 28,054,939                | 11,611,580                |                           |                        |                        | 21.2                    |
| Angola                           | Africa    | Congo Basin              | 25,021,974                  | 44.05         | 0.486                   | 1                  |               |                         | 11,022,180                | 13,999,794                |                           |                        |                        | 21.2                    |
| Argentina                        | Americas  | Southern Cone            | 43,416,755                  | 91.751        | 0.797                   | 1                  |               |                         | 39,835,307                | 3,581,448                 |                           |                        |                        | 7.5                     |
| Armenia                          | Europe    | EasternEurope            | 3,017,712                   | 62.673        | 0.716                   | 1                  |               |                         | 1,891,291                 | 1,126,421                 |                           |                        |                        | 6.5                     |
| Azerbaijan                       | Europe    | Eurasia                  | 9,651,349                   | 54.62         | 0.731                   | 1                  |               |                         | 5,271,567                 | 4,379,782                 |                           |                        |                        | 6.5                     |
| Bahrain                          | Asia      | Middle East              | 1,377,237                   | 88.775        | 0.806                   | 1                  |               |                         | 1,222,642                 | 154,595                   |                           |                        |                        | 7.5                     |
| Bangladesh                       | Asia      | Asia 3                   | 160,995,642                 | 34.277        | 0.5                     | 1                  |               |                         | 55,184,476                | 105,811,166               |                           |                        |                        | 7.5                     |
| Belarus                          | Europe    | EasternEurope            | 9,513,000                   | 76.667        | 0.756                   | 1                  |               |                         | 7,293,332                 | 2,219,668                 |                           |                        |                        | 6.5                     |
| Benin                            | Africa    | West Africa              | 10,879,829                  | 43.95         | 0.427                   | 1                  |               |                         | 4,781,685                 | 6,098,144                 |                           |                        |                        | 21.2                    |
| Bhutan                           | Asia      | Asia 3                   | 774,830                     | 38.644        | 0.522                   | 1                  |               |                         | 299,425                   | 475,405                   |                           |                        |                        | 7.5                     |
| Bolivia                          | Americas  | Andean                   | 10,724,705                  | 68.512        | 0.663                   | 1                  |               |                         | 7,347,710                 | 3,376,995                 |                           | 4.6                    |                        | 7.5                     |
| Bosnia and Herzegovina           | Europe    | EasternEurope            | 3,810,416                   | 39.767        | 0.733                   | 1                  |               |                         | 1,515,268                 | 2,295,128                 |                           |                        |                        | 6.5                     |
| Botswana                         | Africa    | SADC                     | 2,262,485                   | 57.444        | 0.633                   | 1                  |               |                         | 1,299,662                 | 962,823                   |                           |                        |                        | 21.2                    |
| Brazil                           | Americas  | Brazil                   | 207,847,528                 | 85.687        | 0.718                   | 1                  |               |                         | 178,098,311               | 29,749,217                |                           |                        |                        | 7.5                     |
| Bulgaria                         | Europe    | EasternEurope            | 7,177,991                   | 73.948        | 0.771                   | 1                  |               |                         | 5,307,981                 | 1,870,010                 |                           |                        |                        | 6.5                     |
| Burkina Faso                     | Africa    | West Africa              | 18,105,570                  | 29.859        | 0.331                   | 1                  |               |                         | 5,406,142                 | 12,699,428                |                           |                        |                        | 21.2                    |
| Burundi                          | Africa    | Congo Basin              | 11,178,921                  | 12.057        | 0.316                   | 1                  |               |                         | 1,347,843                 | 9,831,078                 |                           |                        |                        | 21.2                    |
| Cote d'Ivoire                    | Africa    | West Africa              | 22,701,556                  | 54.18         | 0.4                     | 1                  |               |                         | 12,299,703                | 10,401,853                |                           |                        |                        | 21.2                    |
| Cambodia                         | Asia      | Asia 2                   | 15,577,899                  | 20.723        | 0.523                   | 1                  |               |                         | 3,228,208                 | 12,349,691                |                           |                        |                        | 7.5                     |
| Cameroon                         | Africa    | West Africa              | 23,344,179                  | 54.381        | 0.482                   | 1                  |               |                         | 12,694,798                | 10,649,381                |                           |                        |                        | 21.2                    |
| Central African Republic         | Africa    | Congo Basin              | 4,900,274                   | 40.037        | 0.343                   | 1                  |               |                         | 1,961,923                 | 2,938,351                 |                           |                        |                        | 21.2                    |
| Chad                             | Africa    | West Africa              | 14,037,472                  | 22.471        | 0.328                   | 1                  |               |                         | 3,154,360                 | 10,883,112                |                           |                        |                        | 21.2                    |
| China                            | Asia      | China                    | 1,371,220,000               | 55.614        | 0.687                   | 1                  |               |                         | 762,590,291               | 608,629,709               |                           |                        |                        | 48.3                    |
| Colombia                         | Americas  | Andean                   | 48,228,704                  | 76.436        | 0.71                    | 1                  |               |                         | 36,864,092                | 11,364,612                |                           |                        |                        | 7.5                     |
| Congo                            | Africa    | Congo Basin              | 4,620,330                   | 65.38         | 0.533                   | 1                  |               |                         | 3,020,772                 | 1,599,558                 |                           |                        |                        | 21.2                    |
| Croatia                          | Europe    | EasternEurope            | 4,224,404                   | 58.964        | 0.796                   | 1                  |               |                         | 2,490,878                 | 1,733,526                 |                           |                        |                        | 6.5                     |
| Cuba                             | Americas  | Caribbean                | 11,389,562                  | 77.074        | 0.776                   | 1                  |               |                         | 8,778,391                 | 2,611,171                 |                           |                        |                        | 7.5                     |
| Czech Republic                   | Europe    | EasternEurope            | 10,551,219                  | 72.992        | 0.865                   | 1                  |               |                         | 7,701,546                 | 2,849,673                 |                           |                        |                        | 6.5                     |
| Democratic People's Republic of  | Asia      | Asia 2                   | 25,155,317                  | 60.875        | 0.766                   | 1                  |               |                         | 15,313,239                | 9,842,018                 |                           |                        |                        | 7.5                     |
| Democratic Republic of the Congo | Africa    | Congo Basin              | 77,266,814                  | 42.494        | 0.286                   | 1                  |               |                         | 32,833,760                | 44,433,054                |                           |                        |                        | 21.2                    |
| Djibouti                         | Africa    | North Africa             | 887,861                     | 77.343        | 0.43                    | 1                  |               |                         | 686,698                   | 201,163                   |                           |                        |                        | 21.2                    |
| Dominican Republic               | Americas  | Caribbean                | 10,528,391                  | 78.98         | 0.689                   | 1                  |               |                         | 8,315,323                 | 2,213,068                 |                           |                        |                        | 7.5                     |
| Ecuador                          | Americas  | Andean                   | 16,144,363                  | 63.742        | 0.72                    | 1                  |               |                         | 10,290,740                | 5,853,623                 |                           | 7.2                    |                        | 7.5                     |
| Egypt                            | Africa    | North Africa             | 91,508,084                  | 43.135        | 0.644                   | 1                  |               |                         | 39,472,012                | 52,036,072                |                           |                        |                        | 21.2                    |
| El Salvador                      | Americas  | Central America & Mexico | 6,126,583                   | 68.726        | 0.674                   | 1                  |               |                         | 4,088,024                 | 2,038,559                 |                           |                        |                        | 7.5                     |
| Equatorial Guinea                | Africa    | Congo Basin              | 845,060                     | 39.923        | 0.537                   | 1                  |               |                         | 337,373                   | 507,687                   |                           |                        |                        | 21.2                    |
| Eritrea                          | Africa    | North Africa             | 5,222,000                   | 37.7          | 0.349                   | 1                  |               |                         | 1,968,694                 | 3,253,306                 |                           |                        |                        | 21.2                    |
| Estonia                          | Europe    | EasternEurope            | 1,311,398                   | 67.538        | 0.835                   | 1                  |               |                         | 886,097                   | 425,901                   |                           |                        |                        | 6.5                     |
| Ethiopia                         | Africa    | SADC                     | 99,390,750                  | 19.472        | 0.363                   | 1                  |               |                         | 19,353,367                | 80,037,383                |                           |                        |                        | 21.2                    |
| Gabon                            | Africa    | Congo Basin              | 1,725,292                   | 87.156        | 0.674                   | 1                  |               |                         | 1,503,695                 | 221,597                   |                           |                        |                        | 21.2                    |
| Gambia                           | Africa    | West Africa              | 1,990,924                   | 59.632        | 0.42                    | 1                  |               |                         | 1,187,228                 | 803,696                   |                           |                        |                        | 21.2                    |
| Georgia                          | Europe    | Eurasia                  | 3,679,000                   | 53.641        | 0.733                   | 1                  |               |                         | 1,973,452                 | 1,705,548                 |                           |                        |                        | 6.5                     |
| Ghana                            | Africa    | West Africa              | 27,409,893                  | 54.042        | 0.541                   | 1                  |               |                         | 14,812,854                | 12,597,039                |                           |                        |                        | 21.2                    |
| Guatemala                        | Americas  | Central America & Mexico | 16,342,897                  | 51.571        | 0.574                   | 1                  |               |                         | 8,428,195                 | 7,914,702                 |                           |                        |                        | 7.5                     |
| Guinea                           | Africa    | Congo Basin              | 12,608,590                  | 37.161        | 0.344                   | 1                  |               |                         | 4,685,478                 | 7,923,112                 |                           |                        |                        | 21.2                    |
| Guinea-Bissau                    | Africa    | West Africa              | 1,844,325                   | 49.332        | 0.353                   | 1                  |               |                         | 909,842                   | 934,483                   |                           |                        |                        | 21.2                    |
| Guyana                           | Americas  | Central America & Mexico | 767,085                     | 28.553        | 0.633                   | 1                  |               |                         | 219,026                   | 548,059                   |                           |                        |                        | 7.5                     |
| Haiti                            | Americas  | Caribbean                | 10,711,067                  | 58.645        | 0.454                   | 1                  |               |                         | 6,281,505                 | 4,429,562                 |                           |                        |                        | 7.5                     |
| Honduras                         | Americas  | Central America & Mexico | 8,075,060                   | 54.73         | 0.625                   | 1                  |               |                         | 4,419,480                 | 3,655,580                 |                           |                        |                        | 7.5                     |
| Hungary                          | Europe    | EasternEurope            | 9,844,686                   | 71.227        | 0.816                   | 1                  |               |                         | 7,012,074                 | 2,832,612                 |                           |                        |                        | 6.5                     |
| India                            | Asia      | India                    | 1,311,050,527               | 32.747        | 0.547                   | 1                  |               |                         | 429,329,716               | 881,720,811               |                           | 12.0 - 35.0            | 37                     | 7.5                     |

Global Dog Rabies Elimination Pathway (GDREP): Phases for a dog rabies elimination program based on 70% dog population vaccination coverage.

| Implementation Phase:      | Phase I: Preparation         |   |   | Phase II: Scale-up dog vaccination |           |           | Phase III: Sustained 70% dog vaccination                     |   |   |    |    |    |    |
|----------------------------|------------------------------|---|---|------------------------------------|-----------|-----------|--|---|---|----|----|----|----|
| Program year               | 1                            | 2 | 3 | 4                                  | 5         | 6         | 7  | 8 | 9 | 10 | 11 | 12 | 13 |
| Expected dog vax coverage: | <18% (current rate)          |   |   | 18% - 35%                          | 35% - 53% | 53% - 70% | ≥70%   |   |   |    |    |    |    |
| Activities achieved        | Field studies                |   |   | Pilot implementation               |           |           | Mass vaccination of dog                                      |   |   |    |    |    |    |
|                            | Workforce training           |   |   | Scaling-up vaccination coverage    |           |           | Surveillance to establish disease burden and assess progress |   |   |    |    |    |    |
|                            | Strengthening lab capacity   |   |   | Logistical improvements            |           |           |  |   |   |    |    |    |    |
|                            |                              |   |   | Operational equipment              |           |           |  |   |   |    |    |    |    |
| Cost estimates:            | Current vaccination coverage |   |   | Expected vaccination coverage      |           |           | Vaccination of 70% of the dog population                     |   |   |    |    |    |    |
|                            | Infrastructure improvements* |   |   | Infrastructure improvements*       |           |           |  |   |   |    |    |    |    |

# Customizable GDREP Tool



## • INPUT

- Country-specific parameters
- Direct comparison to values used in GDREP

## • OUTPUT

- Time to elimination
- Cost per GDREP Phase
- Vaccination personnel needed



# Customized GDREP Tool: Kenya

| Demographic, epidemiological, and cost input variables |   |                |
|--|---|----------------|
| Model Variable   | Input values                                  | Default values |
| Select country   | <input type="button" value="Clear"/> Kenya    | KEN            |
| Discount rate (health outcomes & costs)                | 3%  |                |
| <b>Demographics</b>                                    |   |                |
| Human population                                       | 46,050,302                                    | 46,050,302     |
| Percent urban  | 26%   | 26%            |
| Urban population                                       | 11,973,079                                    | 11,799,008     |
| Rural population                                       | 34,077,223                                    | 34,251,294     |
| Number of humans per dog, urban areas                  | 21.2  | 21.2           |
| Number of humans per dog, rural areas                  | 7.4   | 7.4            |
| Total dog population                                   | 5,169,798                                     | 5,185,110      |
| <b>Dog vaccination</b>                                 |   |                |
| Current dog rabies vaccination coverage (%)            | 11.0%   | 0.5%           |
| Goal: annual coverage of dog population (%)            | 70.0%   | 70.0%          |
| Total dogs currently vaccinated per year               | 568,678                                       | 25,926         |
| Dogs to reach vaccination goal                         | 3,050,181                                     | 3,603,652      |
| <b>Vaccination campaign logistics</b>                  |   |                |
| Vaccinators available                                  | 1,207   | 1,207          |
| Dogs vaccinated per vaccinator per day (rate)          | 100   | 100            |
| Campaign vaccination days                              | 25  | 25             |
| Estimated dogs vaccinated during campaign              | 3,017,500                                     | 3,017,500      |
| Additional vaccinators needed to reach goal            | 241   | 245            |
| Vaccination rate needed to reach goal                  | 120   | 120            |
| <b>Vaccination campaign costs per vaccinated dog*</b>  |   |                |
| Average cost per dog vaccinated                        | <input type="button" value="Estimate value"/> |                |





# GDREP: Country Report

- Who is the intended audience?
  - High-level stakeholders, policy-makers, national rabies control programs
- What are the goals?
  - Highlight the monetary and fiscal commitment that are required for rabies elimination
  - Initiate discussions about funding continuity
  - Establish a strong foundation for multi-year government commitment



# GDREP Tool: How can it be used?

## • WORKSHOPS



## • SARE



Fig 1. Diagram of SARE

## • ONLINE



# Vaccination Calculator

# Vaccination Calculator Planning Tool

- GDREP is a ***broad*** estimate
- How do you make it easier to plan a successful ***local*** campaign?
- **Dog populations** differ between communities
- **Vaccination methods** are more appropriate in certain settings
- **Costs** vary between programs





# Different Dog Populations



Never Confined

Semi-Confined

Confined



# Different Dog Populations

OWNED



Never Confined



Semi-Confined

Confined

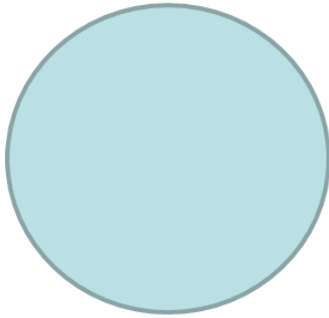


# For each population, a method

|                 |                    |  | Vaccination Strategy Effectiveness |              |        |        |
|-----------------|--------------------|--|------------------------------------|--------------|--------|--------|
| Ownership       | Confinement Status | Contribution to Enzootic Rabies Transmission | Central Point                      | Door-to-Door | CVR    | ORV    |
| Family Owned    | Always Confined    | LOW  | HIGH                               | HIGH         | LOW    | HIGH   |
|                 | Sometimes Confined | MEDIUM                                       | HIGH                               | MEDIUM       | MEDIUM | HIGH   |
|                 | Never Confined     | HIGH   | LOW                                | LOW          | HIGH   | HIGH   |
| Community Owned | Sometimes Confined | MEDIUM                                       | MEDIUM                             | LOW          | MEDIUM | HIGH   |
|                 | Never Confined     | HIGH   | LOW                                | LOW          | HIGH   | HIGH   |
| Feral           | Never Confined     | HIGH   | LOW                                | LOW          | HIGH   | MEDIUM |

# Not all dogs are the same

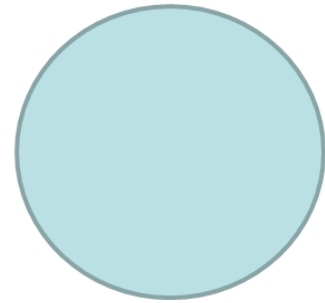
## Enzootic Rabies Transmission Cycles



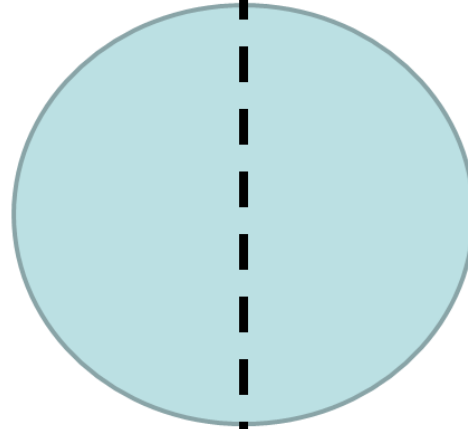
Never Confined



## Opportunistic Rabies Transmission Events



Always Confined

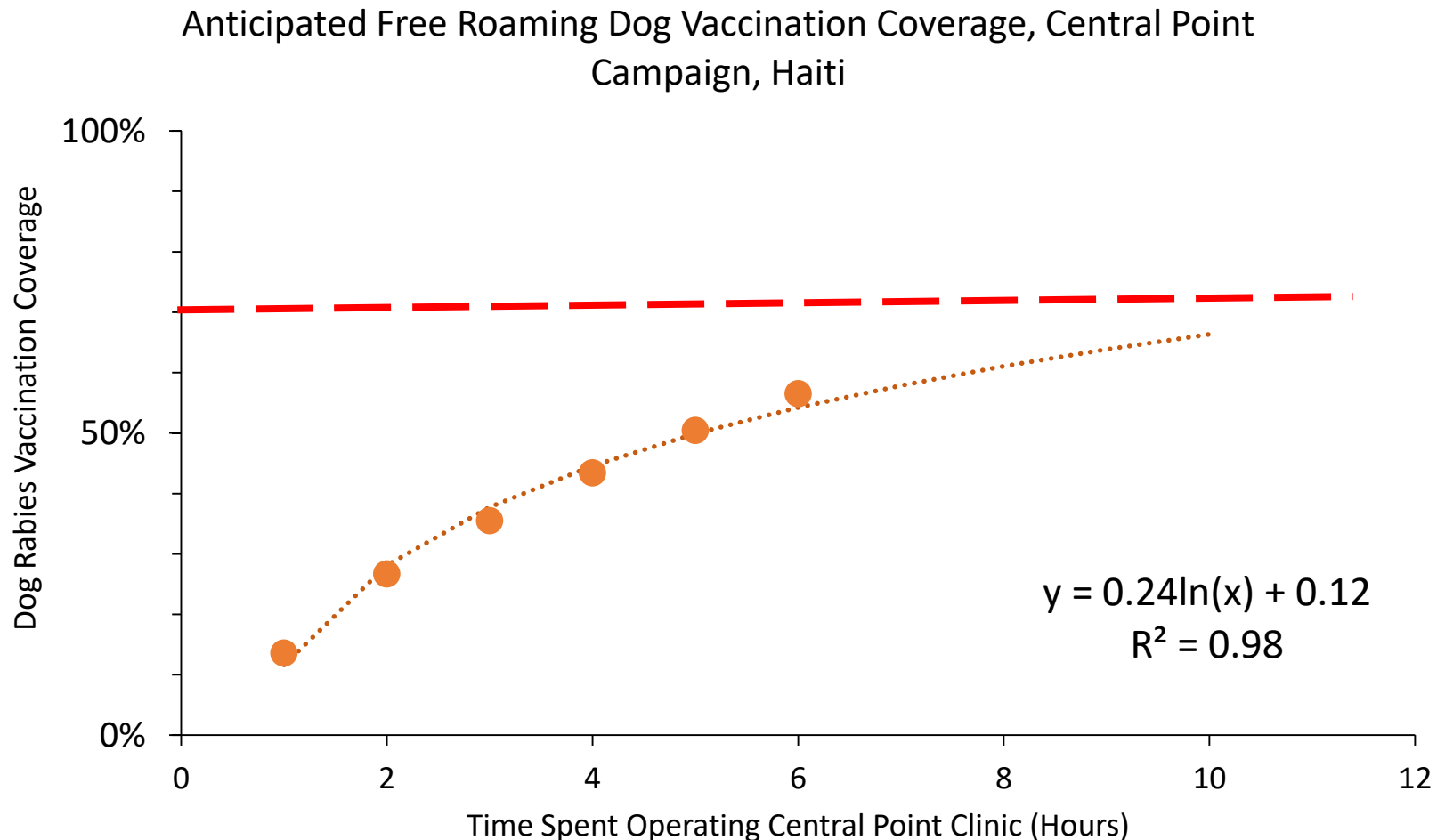


Sometimes Confined



# The method matters!

- Central Point: Projected Vaccination Coverage by Time



# Mass Vaccination Calculator: a planning aid

Central Point

Door to Door

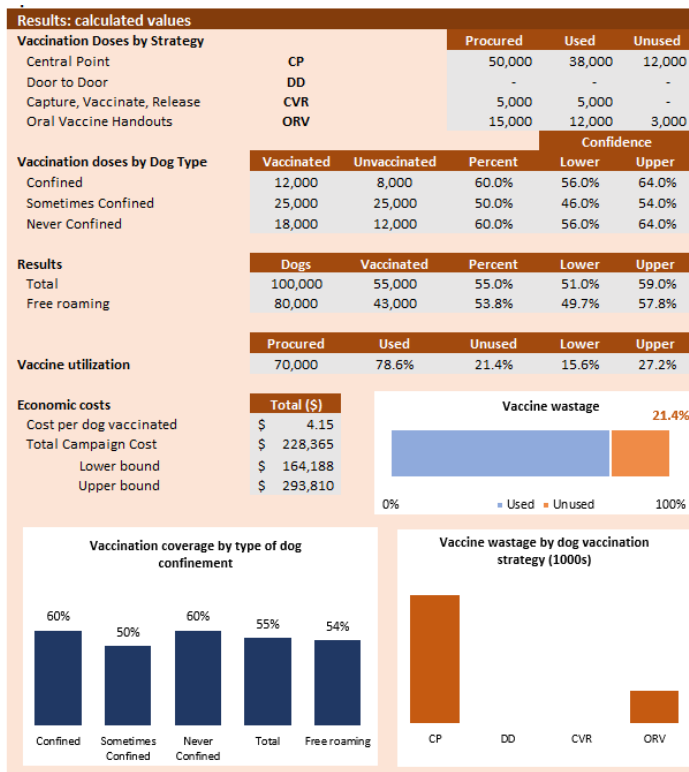
Capture/Vaccinate/Release

Oral Vaccination



## Vaccination Program Calculator

| Required input  |                              |
|---|------------------------------|
| <b>Dog population</b>   |                              |
| Number of dogs in program area (n, %)                             | 100,000 100.0%               |
| Confined dogs (n, %)  | 20,000 20.0%                 |
| Sometimes confined dogs (n, %)                                    | 50,000 50.0%                 |
| Never confined dogs (n, %)  | 30,000 30.0%                 |
| <b>Dog vaccination campaign</b>                                   |                              |
| Parenteral vaccines procured (number)                             | 55,000 100.0%                |
| Oral vaccines procured (number)                                   | 15,000                       |
| <b>Vaccination strategy (doses)</b>                               |                              |
| CP Central Point  | 50,000 71.4%                 |
| DD Door to Door   | 0 0.0%                       |
| CVR Capture, Vaccinate, Release                                   | 5,000 7.1%                   |
| ORV Oral Vaccine Handouts   | 15,000 21.4%                 |
| <b>Expected Vaccination Coverage by Method †</b>                  |                              |
|   | <b>Vaccination strategy*</b> |
|   | CP DD CVR ORV                |
| Confined  | 60% 60% 20% 20%              |
| Sometimes Confined  | 40% 80% 60% 40%              |
| Never Confined  | 20% 20% 40% 60%              |
| How confident are you in your responses to the probability table? | 6                            |
| <b>Suggested values for probability table</b>                     |                              |
| Current country vaccination coverage (%)                          | 55%                          |
| GDREP\$ phase:  | Phase II                     |
| <b>Suggested values:</b>  |                              |
| Confined  | 80% 80% 20% 20%              |
| Sometimes Confined  | 60% 60% 80% 60%              |
| Never Confined  | 20% 20% 60% 80%              |
| <b>Vaccination campaign costs per vaccinated dog†</b>             |                              |
| Average cost per dog vaccinated                                   | Estimate value               |



# INPUT: Design your campaign:

## Required input

### Dog population

Number of dogs in program area (n, %)

|         |        |
|---------|--------|
| 140,000 | 100.0% |
|---------|--------|

Confined dogs (n, %)

|        |       |
|--------|-------|
| 29,400 | 21.0% |
|--------|-------|

Sometimes confined dogs (n, %)

|        |       |
|--------|-------|
| 75,600 | 54.0% |
|--------|-------|

Never confined dogs (n, %)

|        |       |
|--------|-------|
| 35,000 | 25.0% |
|--------|-------|

### Dog vaccination campaign

Parenteral vaccines procured (number)

|        |        |
|--------|--------|
| 15,000 | 100.0% |
|--------|--------|

Oral vaccines procured (number)

|   |  |
|---|--|
| 0 |  |
|---|--|

### Vaccination strategy (doses)

CP Central Point

|       |       |
|-------|-------|
| 3,750 | 25.0% |
|-------|-------|

DD Door to Door

|       |       |
|-------|-------|
| 9,750 | 65.0% |
|-------|-------|

CVR Capture, Vaccinate, Release

|       |       |
|-------|-------|
| 1,500 | 10.0% |
|-------|-------|

ORV Oral Vaccine Handouts

|   |      |
|---|------|
| 0 | 0.0% |
|---|------|

### Expected Vaccination Coverage by Method †

#### Vaccination strategy\*

| CP | DD | CVR | ORV |
|----|----|-----|-----|
|----|----|-----|-----|

## Suggested values for probability table

Current country vaccination coverage (%)

|    |
|----|
| 5% |
|----|

GDREP§ phase:

|         |
|---------|
| Phase I |
|---------|

### Suggested values:

Confined

| CP  | DD  | CVR | ORV |
|-----|-----|-----|-----|
| 20% | 20% | 5%  | 5%  |

Sometimes Confined

|     |     |     |     |
|-----|-----|-----|-----|
| 20% | 20% | 20% | 20% |
|-----|-----|-----|-----|

Never Confined

|    |    |     |     |
|----|----|-----|-----|
| 5% | 5% | 20% | 20% |
|----|----|-----|-----|

### Vaccination campaign costs per vaccinated dog†

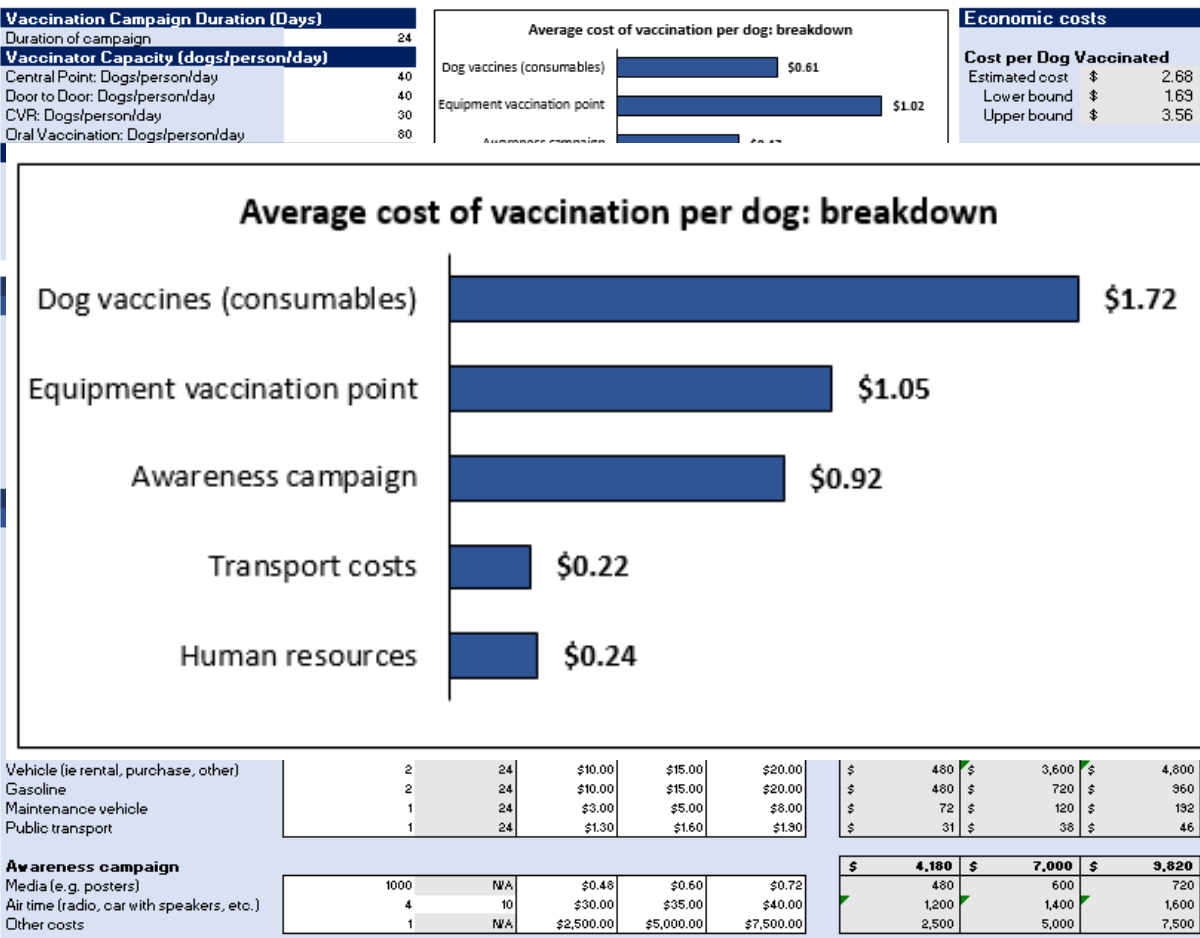
Average cost per dog vaccinated

|                |
|----------------|
| Estimate value |
|----------------|

- Design your own campaign
- Enter your dog population
- Enter the vaccines you will procure
- Enter the vaccine methods you choose
- Estimate the success of those methods

# INPUT: Estimate your costs

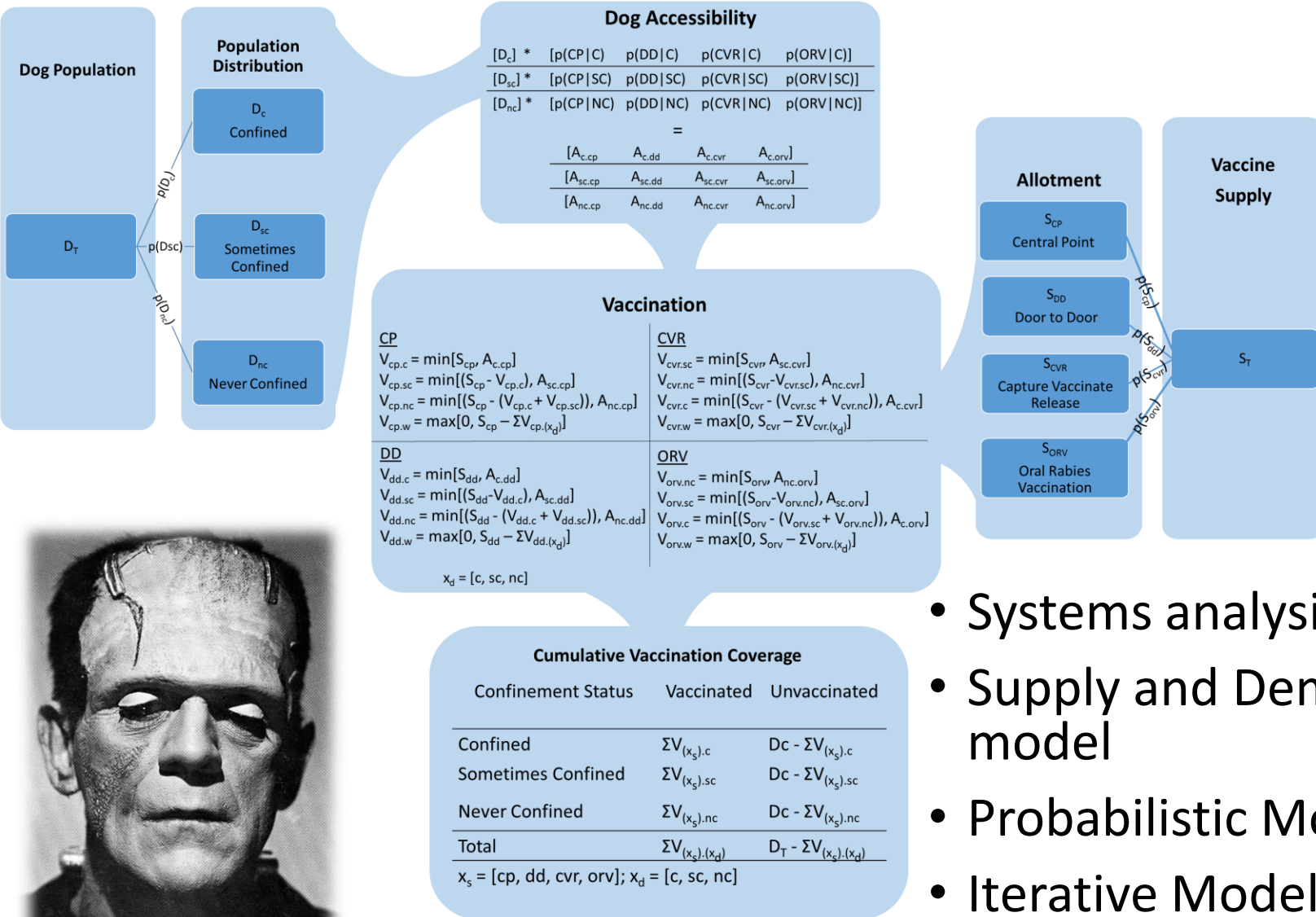
Estimated economic costs of a dog vaccination campaign



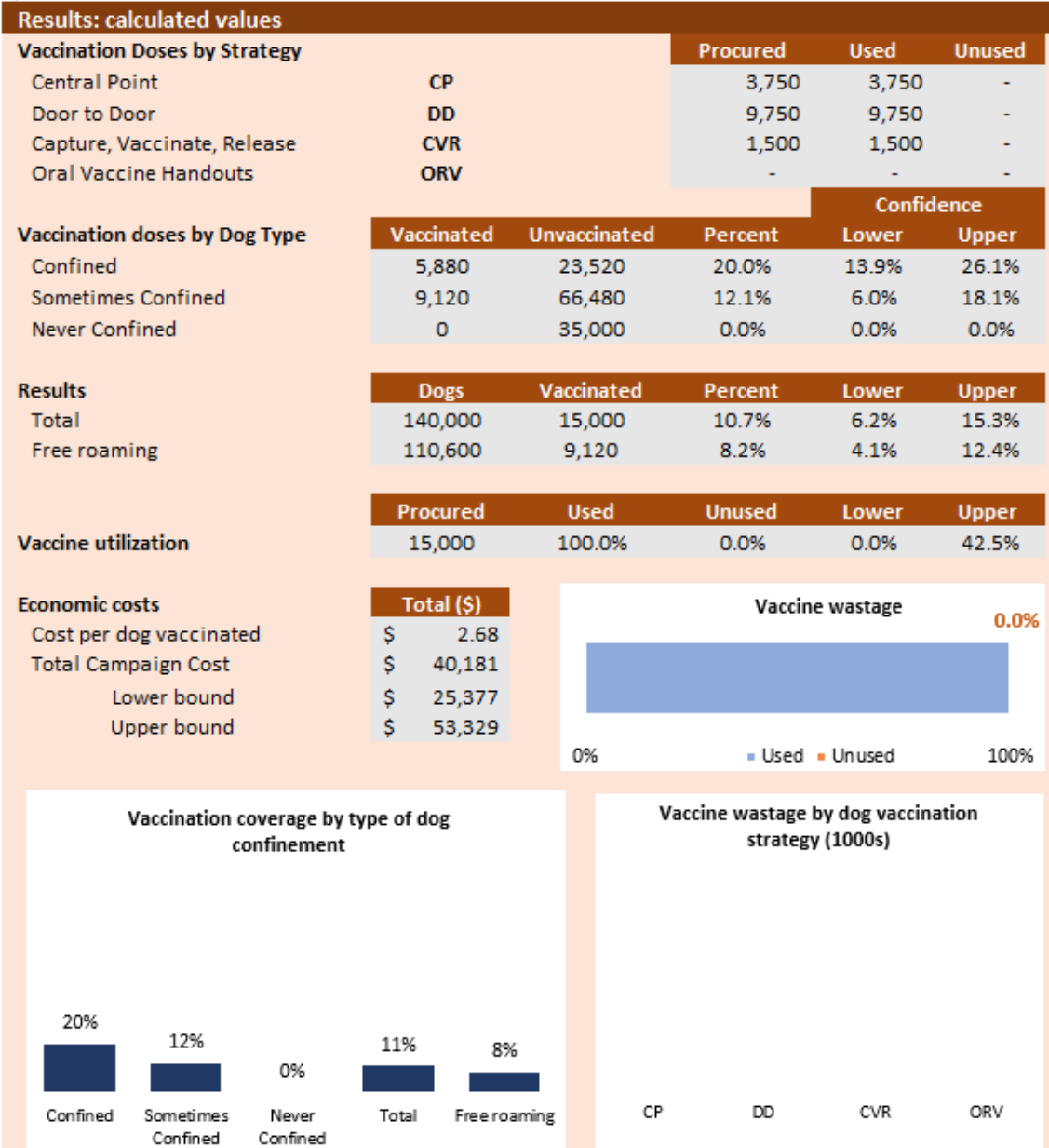
- Estimate the cost to run your campaign!
- Change costs to improve efficiency
- Change duration of your campaign
- Customizable
- Identifies where bulk of costs are allocated



# Vaccination Planning: the method

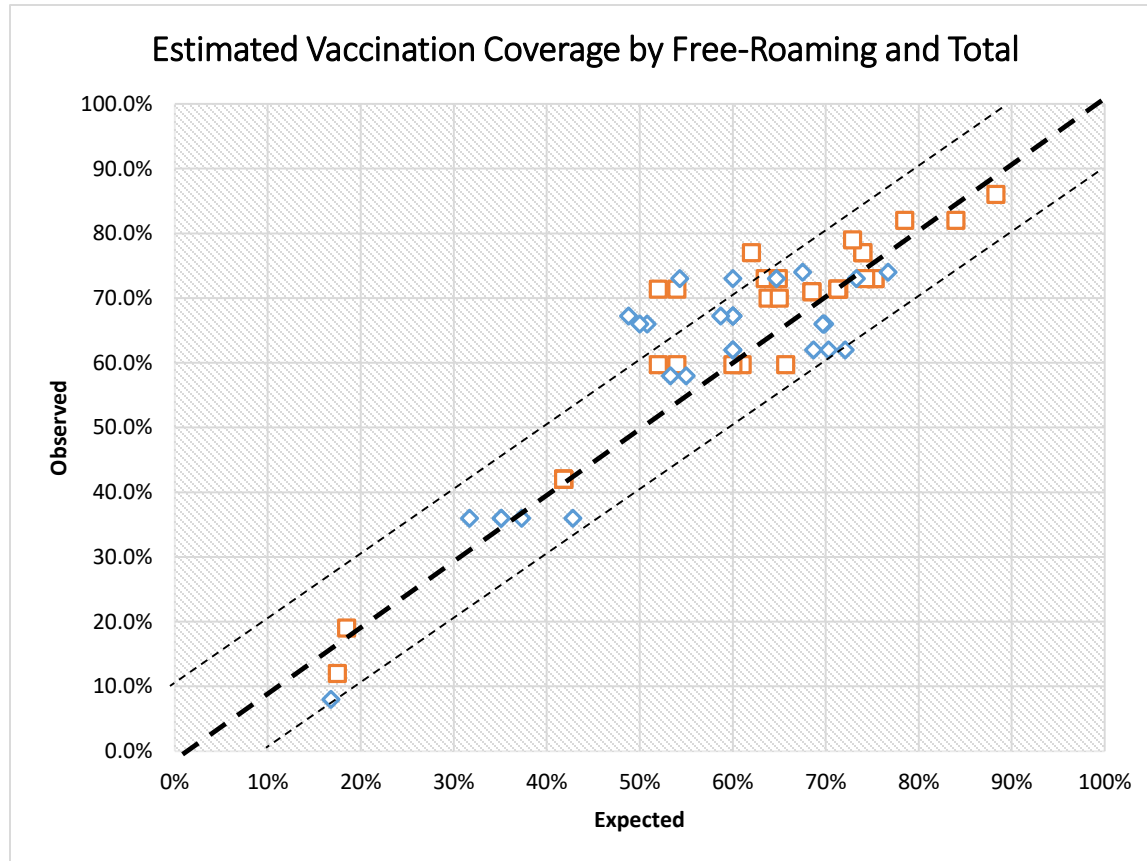


# OUTPUT: Will this be a successful campaign?



- Predicts:
  - Utilization of vaccine doses by vaccination method
  - Expected vaccine wastage
  - Vaccination coverage in Confined and Free-Roaming dogs
  - Total vaccination coverage
  - Cost per dog Vaccinated
  - Total Campaign Cost

# Improving Campaign Planning



Total Dog Population



Free Roaming Dog Population

- Accurate!
- Validated against 12 international vaccination campaigns & 33 individual users
- 95% Confidence Interval within 2% – 4% of “reality”

# Next Steps?

- Currently used as a training exercise in mass vaccination workshops
- Formal evaluation / validation just concluded
- Publication in the near future
- Dissemination shortly after





# Thank you!

- Government Partners

- Haiti Ministry of Agriculture
- Haiti Ministry of Health
- Ethiopia Public Health Institute
- Vietnam Department of Animal Health
- Kenya ZDU

- Universities

- University of the Valley – Guatemala
- Ohio State University
- Georgia State University

- Partners

- GARC
- Christian Veterinary Mission
- Mission Rabies
- Humane Society International
- World Health Organization
- OIE
- PAHO