Sampling plan for Disease Surveillance work in livestock in fringe villages of Manas Tiger Reserve cum National Park, BTAD, Assam

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Introduction:

Manas National Park is situated on the foothills of the Himalayas and a part of it extends to Bhutan. It was declared a sanctuary on October 01, 1928 and was designated a World Heritage site in December 1985. The sanctuary is home to a great variety of wildlife, including tiger, Golden Langur, Wild Buffalo, Hispid Hare, Pigmy Hog, Capped Langur, Indian one-horned Rhinoceros, Elephant, Gaur, Hog Deer, etc. Manas known for its Project Tigers, Rhinos & Elephants, and is Assam's one of the two Tiger projects. The scenic beauty and rare wealth of wild life combine with this unique world heritage site to offer one of the most enthralling experiences.

Need of the study:

These areas present a delicate interface between domestic animals and the wildlife inhabiting the reserve, fostering heightened risks of disease transmission. Vigilant surveillance serves as a crucial tool to prevent the potential spill over of diseases between these populations, ensuring the well-being of both wildlife and livestock.

Moreover, safeguarding the health of domestic animals is vital for the livelihoods of local community's dependent on agriculture and livestock rearing. Timely detection of diseases enables swift response measures, curbing the spread of infections and supporting conservation efforts for the diverse and often endangered wildlife within the protected region.

Additionally, disease surveillance contributes to global health security by mitigating the risk of zoonotic diseases and establishes a foundation for evidence-based research, policymaking, and community education, fostering a harmonious coexistence between humans, animals, and the environment.

A. Target area: Villages adjoining Manas NP & Tiger Reserve in Assam
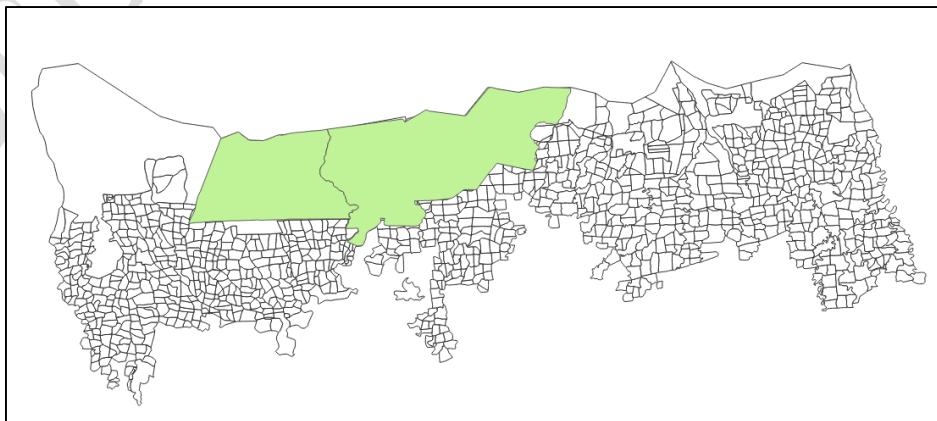

Fig 1. Villages adjoining Manas NP & Tiger Reserve in Assam

B. Major species for disease testing along with approximate numbers:

1. Cattle/Buffalo Population: 15,000

2. Goat population: 2000

3. Pig Population: 500

C. Total Villages to be covered for sample collection: around 45 villages spread in a length of 55km and width of 1km.
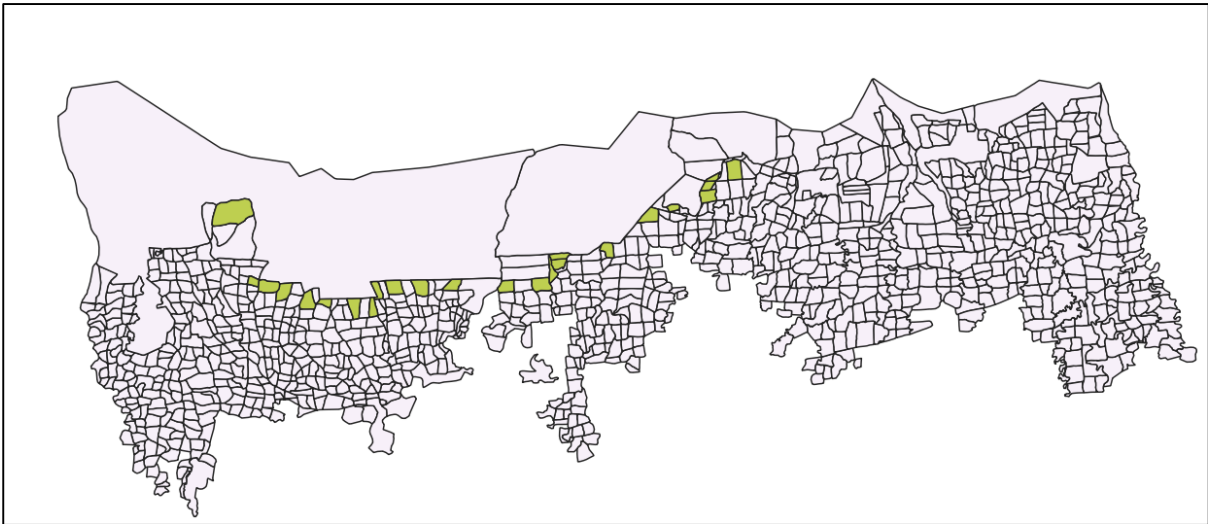

Fig 2. Selected Villages (Green Colour) spread in a length of 55km and width of 1km in Manas NP & Tiger Reserve in Assam

D. Target diseases to be screened as per the species:

1. Cattle/Buffalo: i. Theileriosis, ii. Brucellosis ii. LSD,

2. Pig: i. ASF ii. CSF iii. CIRCO iv. PRRS

3. Goat: i. PPR, ii. Brucella iii. Orf

E. Sampling Plan:

We have employed a **Systematic Sampling** methodology to ensure comprehensive coverage and accurate representation. Initially, we identified **48 villages (Population List)** situated in the periphery of the National Park. Subsequently, we adopted a systematic sampling approach to choose approximately **24** (20+4*) **villages for surveillance**. This method involves the systematic selection of every kth (2nd) village from the total population, where the sampling interval is determined by dividing the total number of villages by the desired sample size.

The formula for systematic sampling involves determining a sampling interval (k) and then selecting every k^th element from a list (Sampling was carried using python code):

1. **Calculate the Sampling Interval (k):**
   k = Total number of villages / Desired sample size (48/24 = 2, every 2nd village was selected)

2. Randomly Select a Starting Point:

Choose a random number between 1 and k. This is the starting point for systematic sampling.

3. Select Sample Villages:

Starting from the randomly chosen starting point, select every kth village until you reach the desired sample size. Using the above procedure, we have selected approximately 24 (20+4*) villages

Estimation of the Population Mean

1. The population mean (μ) is estimated with

$$\hat{\mu} = \frac{\sum\limits_{i=1}^{n} y_i}{n}$$

2. The population variance (σ^2) is estimated with

$$s^2 = \frac{\sum\limits_{i=1}^{n}(y_i - \bar{y})^2}{n-1}$$

3. Variance of the estimate μ̂ is

$$\hat{var}(\hat{\mu}) = \left(\frac{N-n}{N}\right)\frac{s^2}{n}.$$

4. Standard error of μ̂ is

$$SE(\hat{\mu}) = \sqrt{\left(\frac{N-n}{N}\right)\frac{s^2}{n}}.$$

n: Sample size, N: Population size, y_i : ith member of systematic sample (i = 1, 2..,n)

Details on the number of animals to be sampled

- Design Level Prevalence = 0.30
- Cluster Level Prevalence = 0.06
- Sensitivity of the test used = 0.9
- Total No of Villages (Clusters) Selected = 24 (20+4*)
- Total No of Animals to be Sampled = 160
- Total No of Animals to be Sampled per village = 8

* 4 Villages can be considered as reserved villages

Guidelines for collection of random samples within the village

Given below is the example provided by us to the coordinating unit for sample collection.

<u>Example:</u> If you are asked to collect 5 samples from a village having 17 animals (cattle & buffaloes together), you are supposed to do sampling as follows;

In a table, enumerate and list all the households/owners having the given species of animals. Say for example there are three owners viz., Avinash Alur, Avinash B, Avinash Sunkad in the village with 7 (5 buffaloes & 2 cattle), 6 (3 buffaloes & 3 cattle), 4 (cattle) number of animals respectively, then make the sampling frame as follows;

S. No.	Owner (Hosuehold)	Total (Cattle+Buffaloes)	Temporary ID	
1			AA1	
2			AA2	4th sample
3			AA3	
4	Avinash Alur	7	AA4	
5			AA5	5th sample
6			AA6	
7			AA7	
8			AB1	
9			AB2	
10			AB3	1st sample
11	Avinash B.	6	AB4	
12			AB5	
13			AB6	2nd sample
14			AS1	
15			AS2	
16	Avinash Sunkad	4	AS3	3rd sample
17			AS4	

Pick a random number between 1-17 (as the village has total 17 animals)

Say, you picked 10 (S. No. 10), then identify the household/owner the pointing to the said serial number. In this case, it is house of Avinash B. Since you have to collect 5 samples from the list of 17 animals (17/5=3.4, round that to 3), mark every third animal in the list as shown above. Once you have identified the owners and the animals, go to the identified owners house, stand at the entrance/entry point of pen (shed), number the animals serially in a clockwise manner (remember line also makes part of the circle) starting from the one nearest to the entrance/entry point. In this case, it is third nearest animal from the entrance of the pen of Mr. Avinash B. Similarly, collect all the required samples as shown in the table. You should visit all the identified houses to collect samples.

Alternatively, you can hypothetically divide the village in to four quarters and pick the requisite number of samples from households as shown below
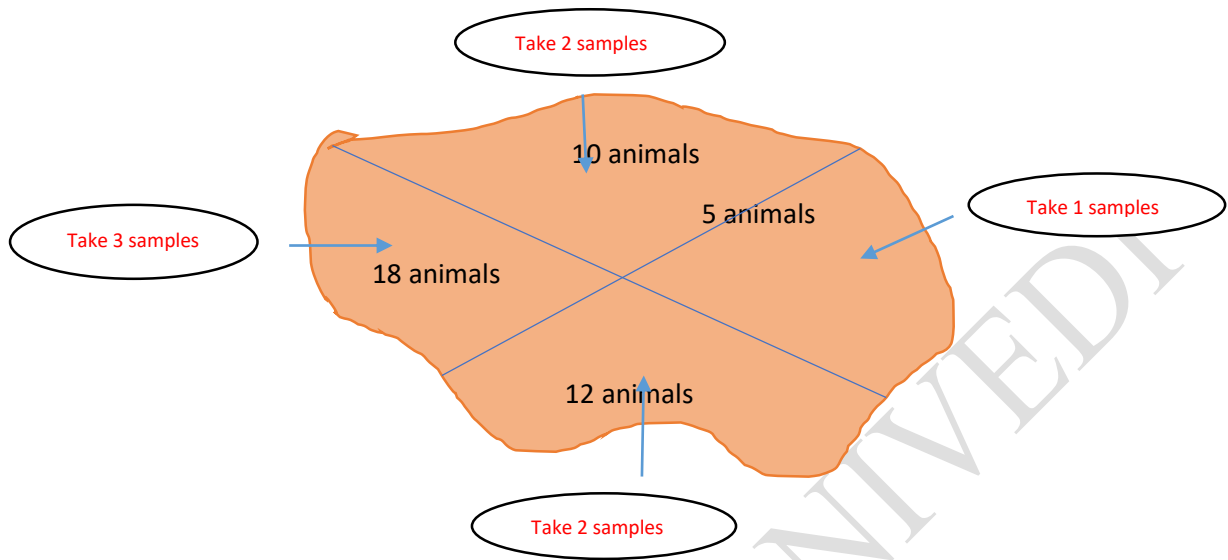
References:

1. https://www.nivedi.res.in/Nadres_v2/pdf/nadres_bulletin/2023/BBMP%20Street%20Dog%20Survery-2023
2. https://www.nivedi.res.in/Nadres_v2/pdf/Sampling%20Plan%20Reports/2023/3.1_Final_FMD_Serosurveillance_Sampling_plan_2023.pdf
3. https://www.nivedi.res.in/Nadres_v2/pdf/Sampling%20Plan%20Reports/2023/1.1_Final_Report_FMD_Seromonitoring_Round_IV__21-09-2023.pdf
4. https://www.tigerreserves.com/information_in_manas_tiger_reserve.php