The Concept And Methods Of Community Participation In Animal And Human Disease Surveillance

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Abstract

Background: Animal health surveillance is essential to protecting public health, controlling animal diseases and accessing international animal trade with a view to ensuring food security. The practice of subsistent agriculture makes laboratory disease surveillance and statistics difficult or impracticable to implement. Many times, the information generated through conventional approach may not reflect true field situations. Therefore, animal health project interventions from conventional data may be difficult to implement. Community engagement, however, empowers and ensures lasting solutions to developmental challenges.

Methods : Field experiences and a review of the origin, concepts, methods and tools of Participatory epidemiology (PE) in disease surveillance suggest their appropriate uses.

Results : Community participation in animal and public health investigation, program design, implementation and monitoring is credited with ownership, acceptability and sustainability.

Conclusion : This research highlights how and why participation is an essential component of a successful disease surveillance design and implementation. However, the success of any participatory program depends on understanding the bases and applications of the right tools.

Background

A good design of any community-based project would depend on the objectives of the project in line with the needs of the community, and the project documents should clearly identify the sectors that would be supported. Participants are also expected to voluntary share their knowledge, resources and skills to take effective decisions that may affect them. At the end, researchers and stakeholders learn and get the best opportunity to develop solutions to developmental challenges [1–4]. Participatory epidemiology (PE) is an offshoot of participatory rural appraisal (PRA), being an intelligent data gathering process. The approach uses triangulation or multiple probing techniques to guide the quality of data generation. The participatory approach is adequate in applied research, needs and impact assessments [1, 2, 4]. In public health, PE serves as active disease surveillance by representing a systematic use of consultative approaches and interactive methods to timely identify outbreaks, improve understanding of diseases occurrences and expose best options for disease control [5].

The PE concept was introduced into developing nations by the medical anthropology and participatory rural appraisal schools of thought [6]. In animal health, it was first developed to enhance the effectiveness of rinderpest surveillance in pastoralist communities. Due to its sensitivity in outbreak detection, it is presently applied in search of animal and human diseases in pastoral and mixed rural farming communities [4, 7]. It is what Pfeiffer [8] referred to as evidence base Veterinary Medicine where interaction between clinician: animal: animal owner exists to yield the best and economically sustainable clinical outcome. It is gradually becoming acceptable as an excellent data generating technique that may

overcome some of the short comings of conventional epidemiology [4]. Common and rare animal diseases can henceforth be put under control through PE approach in Africa and Asia [4].

Today, animal health surveillance is essential for protecting public health, timely control of animal diseases, accessing international markets, and improving animal health, production and welfare [7]. A surveillance system that uses the participatory concept is likely to enhance regional animal disease surveillance performance, increase surveillance sensitivity and timeliness through involvement of the rural communities [4, 9[. Many years ago, livestock farmers provided vital information that led to the final eradication of rinderpest in areas where conventional methods had failed [7]. When PE approach is fully understood, adapted and officially integrated into animal and human health contingency plans, effective and sustainable national disease control program would be guaranteed.

Methods

Participatory evaluation of important livestock diseases and impediments to animal health were conducted in four northern Nigerian states (2012-2018). Results were discussed along side with literature search of the origin, concepts, methods and tools of Participatory epidemiology (PE) in disease surveillance to enable appropriate us to potential users.

Investigation into how Participatory Epidemiology Started

Traditional communities are a rich source of practical agricultural knowledge and pastoralist in particular, understand the history, presentation and epidemiology of important livestock diseases. [10]. Before the emergence of PE, veterinarians and social scientists had used participatory approaches in the early development of community-based animal health workers (CAHW) in India [11] Afghanistan [12] and Africa [13, 14]. Also, participatory research in ‘ethno-veterinary practices’ related to animal health became popular and was termed existing veterinary knowledge (EVK). This knowledge was recognized to have made important contributions to mordern medicine. In line with this therefore, we conducted some focus group discussions using a check-list guided semi-structured interviewing method in selected rural areas of Bauchi, Gombe, Katsina and Plateua states, Nigeria with a view to revealing livestock traditional health practices.

Evaluating the Sensitivity and Reliability of Participatory Disease Investigation

Participatory appraisals are based on two important principles which are designed to improve the quality and reliability of the information gained [1].

1. *Triangulation*. Information is screened and data generated using different authenticating procedures usually involving a minimum of three checking processes hence the name triangulation. It serves as means of improving information quality and accuracy needed for investigating linkages within farming communities. Related events are chosen and combined for their degree of mutual interdependence and ability to get needed information.

2. *Probing*. Probing means to ask detailed questions on a specific subject raised by the respondents which serves as a data gathering and quality control technique. Probing can be used to verify the internal consistency of information or to further gather detailed information on a particular subject. Probing is known for its ability to expand on the description and understanding of diseases by the respondents.
3. *Flexibility*. This is an important concept that is used 'to plan the work and also work the plan' in a desired manner that allows for creativity and modification where necessary. It involves the ability to invent, choose, alter, or combine methodological approaches, tools and techniques in PRA. This is because rapid appraisals are not rigidly planned and executed without deviation, but the techniques used and questions asked can be changed at any point during the investigation.

Another reason that makes participatory investigation results sensitive and reliable is the source of data where principles of flexibility and triangulation are applied in the generation. The data are of primary or secondary sources, depending on their closeness to the actual subjects of study [1]. Primary data sources include direct observation, group and individual interviews of farmers, interviews with key informants such as village elders, local religious leaders and government officials familiar with the area. Also included are the outcomes of participatory activities like community based initiated annual animal vaccination campaign, development of community grazing lands and watering points undertaken by communities to alleviate local animal health problems. The secondary data sources include previous studies and reports, government statistics and records, maps of the area in question, research papers and even historical texts. It is usual to consult as many secondary data sources as possible before undertaking field work so that issues to be given priority attention in the field study are highlighted.

Comparison of Formal Sampling and Participatory Methods in Epidemiological Studies

The formal randomised study is mainly based on probability and is typically associated with errors that need to be reduced when making inferences from sample data [8]. In fact, errors derived in population estimates using cluster sampling are often higher than those from simple or stratified random sampling procedures [8]. Sometimes random sampling may be difficult or impossible to carry out because of certain circumstances that may include:

a. Where target populations are scattered over a wide and remote areas and units within same clusters tend to be more homogenous than those from different clusters thus making access and drawing-up of an appropriate sampling frame difficult or even impossible.
b. When the factors to be studied are very large, unknown or very variable, and there is no basis upon which to create a sampling frame.
c. If the study is aimed at looking for many factors and variables to which a sampling frame appropriate for one factor may be too large or too small for others.

Some surveillance data might cause massive measurement errors thus necessitating repeated surveillance. Conventional random surveys are designed around a particular need on a large-scale and

may require a large number of field staff. These staff need not be of a particularly high level of training, but should understand the questionnaire they are using and be able to take appropriate samples if required. Appraisals, on the other hand, require a single small but specialised team to carry out an in-depth study of a number of factors playing a role in a given community. Overall, the costs of PRAs are thus much lower [27]. Advantages of participatory methods are enormous some of which are listed below.

1. Often the only way of gathering data from certain remote areas.
2. Usually cheaper and more feasible than formal surveys.
3. Results are usually available very timely.
4. More flexible and able to adapt to new issues uncovered during the appraisal.
5. An effective method for the design of more conventional studies through better identification of the depth and priority of issues for quantitative study.
6. Participatory methods build on what local people already know, this enables them to use their own knowledge and skills in disease surveillance and control.
7. Participation is a reasonable tool for empowerment of the rural women.

Basic limitations of participatory methods in epidemiological studies

Participation research is also associated with risks that may directly impact on major findings if not handled adequately. Participatory research can be time and resource consuming if not well planed; (ii) it can also be logistically difficult to achieve if bias is not avoided; (iii) conflicts among participants is common if stakeholders are not duly represented; (iv) sometimes consultative groups may be a source of conflicts if not well chosen; (v) during political seasons, higher expectations are unavoidable; (vi) powerful and more educated participants would dominate sessions to give unfair judgments; and (vii) where capacity is inadequate, good conclusions are hardly drawn. A researcher must therefore, look into and address these likely situations. It is wrong to assume that PE approach in the beginning will provide sufficient and valid understanding of all situations for all future interventions. It must be remembered that the approach also initiates additional formal studies to verify participants' diverse responses and claims which may render initial researchers' guesses not given due credibility [18]. Where focus of intervention is not appropriate, much time is spent using this approach and so timely projects are unduly delayed or confused if rushed. Therefore, recognising PE limits can prevent inappropriate focus and enhance better decisions [18]. Bias which must be avoided in epidemiological study is unavoidable in PE due to its targeted operational subjects, participants and operational framework. Flexibility is critical and a key factor in any PE evaluation. When abused will lead to group or individual manipulation of data that would be difficult to estimate the degree of confidence placed on such data [18]. As statistical analysis becomes more complex, the PE process becomes somewhat similar to conventional research with researchers extracting information from local people and, if so, this raises important dilemmas for PE practitioners.

The Basis of the Techniques and Tools used in Participatory Epidemiology

Rural appraisals generally involve the deliberate selection and combination of a number of research methods, tools and techniques to suite particular research needs. For instance, to efficiently utilize local indigenous knowledge, there is the need for semi structured or informal interviewing that will be guided by check list and key informants. Other methods may include direct observations, use of indicators, time-space, logic schematics, aerial photographs, maps and direct measuring tools [18]. Techniques that have proven useful include organized interview protocols, selection of respondents, focus groups and ways of handling interview introductions, settings and contexts. Observational techniques include field or transect walks. Generally, the selection of tools and techniques is decided during the course of the interview and for it to be most effective, team members should know how to use most of the potentially useful tools and techniques in advance [18]. Recording devices like camera, video camera, tape measure, scale, range finder and global positioning system (GPS) device are other essential PE tools [23]. Numerous tools usually grouped in to four have been long developed for use in PE investigation to assist with communication [1, 20].

1. ***Informal interviewing***: Semi-structured interview (SSI) with key informants (KI), individual interview (II) or focus group discussions (FGD)
2. ***Ranking and scoring tools***: Simple ranking (SR), pair-wise ranking (PWR), proportional piling (PP), matrix scoring (MS)
3. ***Visualization tools:*** Mapping (M), Venn diagrams (VD), seasonal calendars (SC), and timeline (TL)
4. ***Direct observation***: Transect walk (TW), clinical and postmortem examinations.

Appropriate Application of Semi-structured and Informal Interviews

Informal interviewing is an art that needs a sensitive balance between open-endedness and direct enquiry. It is assumed that the researcher does not know how to ask and yet covering the major concerns. In this approach, there is no formal pre-set questionnaire but a checklist of questions which the interviewer uses as a flexible guide to cover a set agenda. If well set it is an effective tool for diagnosing rural problems and opportunities that can be used by professional researchers who may lack extensive field experience [19]. Semi structured interviewing is flexible which enables researchers to rapidly change directions as new information unveil [23]. Below is a suggested tabulated guide to semi-structured interviewing.

Table 1: Summary guidelines for semi-structured interviews and check list used in participatory Disease surveillance

S/No.	Activity	Best way to conduct the activity
1	Self preparation	Define the topic to investigate, work out the key questions you want to ask.
2	Introduction	Introduce yourself and the purpose of the meeting explaining why you have come and why the interest in the selected topic
3	Attitude and language to use	Be friendly, informal, and respectful and try to sit on the same level as the participants. Stay calm and never be emotional
4	How to question	Start with general questions/comments: This will put people at ease. The easiest thing is to start with something visible that everybody can agree with. Use simple language, avoid scientific words and mix questions with general discussion: This keeps the interest of your informants and ensures good communication. Ask one question at a time; avoid leading, long and complicated questions or questions with 'yes or no' answers. Use the six helpers (why, how, who, what, when, where) will help probe many doubtful information.
5	Dealing with illiterates	Use diagrams, symbols and drawings: help to keep people interested and ensures full participation and understanding.
6	Observation	Make sure everyone participates and not dominated by few individuals. People should not be bored, 90 minutes is the maximum for best group interviews.
7	When the interview is over	Thank your informants and give them an opportunity to ask questions. This is polite and gives valuable clues.
8	Note taking	Make full notes after the interview: unless you have a note taker.

Table 2. Check list of possible tools to be used for participatory epidemiology evaluations

S/No.	Activity	Useful tool for evaluation
1	Introduction and purpose of visit	SSI
2	Livelihood activities	SR, PP, PWR
3	Livestock relative populations and species kept	SR, PP, PWR
4	Livestock husbandry practices and challenges	Mapping, SR. PP, PWR
5	Evaluation of livestock diseases/challenges in 4	SR, PP, TL, DIMS, PP for MM, SMS
6	Access to veterinary services and traditional livestock disease management	EVK
7	Questions and comments from participants	SSI
8	Verification/visit to places with ongoing outbreaks	TW

The Importance of Key Informants in Participatory Surveys

Key informants are often very knowledgeable persons like field social anthropologist who do not fully realize what they know but can provide most useful insights and raise unexpected issues. Other local key informants found useful in field studies were agricultural extension workers, persons in charge of clinics, opinion leaders and school teachers who are better educated in the communities [22, 27]. Special efforts to identify informants is necessary and this can be done by asking in any subject of interest who or which group of people are more knowledgeable and then work with them [19]. Key informants are however, individuals with more extensive knowledge and can talk about the system beyond their own limited participation. They are expected to answer questions on the knowledge and behavior of others. They should also be accessible, willing to talk and have depth of knowledge about an area [18, 19, 28]. In our opinion, agricultural extension officers best suit key informants in evaluating animal health issues in rural communities of northern Nigeria [28].

Conducting Group Interviews in Participatory Surveys

Group interviewing is an important way of learning about local situations by asking participants what they know about. People differ in knowledge, willingness and verbal capabilities of expressing information and some depend on their friends to remember previous events [29]. Rapid appraisals consider interviews as the most important research methodology to which seven related issues listed here are paramount: (1) Selection of respondents, (2) individual versus group discussions, (3) timing of the interview, (4) strategies for getting the most out of the interview, (5) use of interpreters, (6) note taking, (7) appropriate locations for the interview [19, 30]. Individual and group interviews have been used in rapid appraisals with individual interviews exploring mainly personal or household information that may a time generate conflict within the community [31]. Individual interviews often target model/educated farmers, government officials, opinion leaders, children, businessmen and individuals that have adapted a research technique. The aim is to evaluate appropriate experiences [24]. Different categories of group interviews include special, random and stratified groups aimed at evaluating community responses on interventions [22]. Group interviews enable access to a larger body of knowledge and mutual checking but could also be misleading especially when the interviewer has power to control benefits or sanctions. However, it is particularly useful in obtaining information involving natural resources of a wide geographical area and is also good to access certain sensitive social information. For instance, group interviews can be used to collect certain true sensitive information that an individual may be penalized for releasing such information [30]. There usually exists a self-correcting mechanism within group discussions, if one person puts across certain points, a peer would give a more realistic observation and cross checking with other groups gives a higher degree of information uniformity [19, 31]. However, when groups become too large, management becomes a problem as the group tends to split in to smaller sub-groups, especially when dominant and influential speakers exist [31, 32].

Selection of respondents

Two key individuals, respondents and key informants are usually interviewed in appraisals. Respondents are purposively selected on the basis that they are beneficiaries of a programme or study but most importantly they represent a cross section of the target population. Farmer leaders or farmers who were privileged to try recommended technologies, women that are farmers and household heads, poor farmers with limited resources and traditional farmers who have resisted new technologies may be good respondents [18].

Scheduling of interviews

The interviewer must be aware of the daily work schedule, seasonal activity, work habits, climate and their effects on respondents' willingness to attend the interview because interviews should not be able to hamper important work [33]. From experience, the period immediately after crop harvest period is an ideal time to conduct interviews in northern Nigeria [32].

Use of interpreters

Rapid appraisal team members are expected to speak the local language of the study population, where this is not obtainable, an interpreter must be used. Careful choice of interpreters is necessary especially those that can understand the questions. It is more preferable that the team should go over the interview strategy with the interpreter before the interview. The team members should be brief using fewer words to express complete thoughts and the translator given enough time before proceeding to the next question. It is also recommended that the interviewer should talk directly to the respondent as if the respondent could understand him [33]. An electronic recorder used carefully could assist in further information verification [28, 32].

Recording of information

There are differing opinions in recording information in front of respondents. Some believe that this act restricts the spontaneity of respondents' reactions while others don't [34]. However there are reports of how facts, ideas, and important observations slipping away if not recorded. In fact, 50 percent of the details of an interview are lost within 24 hours and by the end of second day, over 70 percent is lost [33]. Notwithstanding, an officially looking questionnaire destroys respondents confidence and therefore should be avoided during the interview instead the ground should first be tested by interacting with respondents while drawing lay outs or maps on a paper and careful use of electronic recorders may assist [28, 32, 33].

Location for the interview

Appraisal interviews should as a rule is conducted under conditions most relevant to and revealing about the local system being investigated. Interviews in the field permit more confidential discussion with farmers and possible field observations may identify new topics for discussion. Participants also feel most honoured when met in the field [28, 33].

The Use of Simple Ranking Tool in Participatory Surveys

Simple ranking is a quick fast and easy way of gathering data to help the researcher to understand issues from the respondent's point of view and allows room for many participants. In SR, lists of items based on define criteria which may include livestock species, diseases, occupations, housing types etc. In this exercise participants are asked to name livestock that are kept in the community. These are written on cards and participants asked to organize the cards in order of population. If the cards are ranked, the interviewer asks if they all agree and further asks probing questions to find out why they ranked certain items first and others last. The criteria for the ranking should be clear to both the investigator and the informants and then carefully recorded along with the results [1, 35].

Pair-wise Ranking Tool in Participatory Surveys

Pair-wise (PWR) or comparison ranking is slightly more complex and takes more time to conduct than SR. In this exercise, each listed item is compared individually with all the other items one-by-one making PWR more reliable than SR as it also assists the participants look in to other possible relationship before decision to rank is reached. It becomes useful where informants cannot reach consensus using SR or if

two items happen to have the same scores. Pair wise ranking serves a probe to SR because it can be used when there are disagreements among informants during SR [1, 32, 35].

The Proportional Piling Tool in Participatory Surveys

Proportional piling is a PE tool used to rank livestock species by numbers and their relative importance. Participants will first list the livestock species kept in the community. This procedure assumes that 100 counters represent 100% of livestock population in the community. Circles are drawn on the ground or on flip chart to representing each animal species. Participants are made to allocate or divide 100 counters (beans or maize seeds) in to the circles in piles, representing a number of categories, by agreed criteria for instance, according to the relative numbers of each species with the highest score indicating the most abundant livestock specie in the area. Proportional piling technique can be adapted to study issues such as:

– Disease prevalence and incidence

– Morbidity, mortality and case fatality rates

– Clinical presentation

– Epidemiological risk factors

– Relative incidence of diseases in the community and vaccination impacts

– The efficacy of disease interventions.

The Concept and Application of Matrix Scoring in Participatory Surveys

Simple matrix scoring (SMS) is used in veterinary epidemiology to understand local characterization of livestock diseases and meanings of local disease names. The concept can be used to define and assess impacts of diseases or interventions. The procedure involves four steps:

1. Identification of items to be scored
2. Pair-wise comparison of the named items
3. Scoring of diseases versus indicators
4. Interviewing the matrix constructed

Matrix scoring uses a two-dimensional grid used to score items by at least two sets of categories. The researcher can use the completed matrix in short, semi-structured interviews to follow up interesting results and cross-check information [1, 35].

Assessment of economic impact of livestock using impact matrix scoring method

Impact matrix scoring uses SMS principle, here indicators such as benefits of keeping livestock are first weighted and then compared to categories like livestock species. A proportional piling exercise is then employed on the indicators before the counters are distributed across the categories to create a matrix. First list the common livestock species in the community (items). Then obtain a list of benefits derived from each livestock mentioned (indicators). You may use pictures to represent the indicators. Score counters by PP on the indicators according to their importance to likelihood and record. Place pictures on top rows of matrix (*y* axis) and indicators on side columns of the matrix (*x* axis). Ask the participants to use counters (100) to show how strongly the indicator correlates with each items. Repeat for each indicator to build a matrix (Fig. 3). Summaries and crosscheck on how they are scored. Give participants the opportunity to make changes if they wish. It is possible to sum up number of counters in each column to give an indication of how important the category is to the participants or its overall impact [1, 35, 36]. If carefully conducted, the researcher appreciates a lot of socio-economic benefits of livestock activities within communities as revealed by the participants [28, 31].

The use of matrix scoring in disease definition

An important step in any PE study is to understand how farmers think about diseases and characterize them. Perceived association between livestock diseases and farmers recognition of clinical signs and risk factors can be investigated using MS. Matrix scoring can be a very useful tool for understanding disease symptoms and epidemiological characteristics of the diseases described by farmers. In this approach, simple matrices were constructed on the ground. In certain animal species, various clinical signs/features and or risk factors formed the *y* axis and the likely diseases affecting such species of animals formed the *x* axis. For each clinical sign or risk factor, participants would be made to allocate (score) 25 or 30 counters in proportion to their relative importance for the different diseases mentioned. Participants will be allowed to fully discuss the disease syndromes they described and then the facilitator should discuss the definitions developed by the participants. Then the facilitator uses his own veterinary knowledge or crosschecks the conclusions with experts, textbooks, and direct observation of clinical cases [1, 9, 34, 36].

The Importance of Mapping Communities in Participatory Surveys

Drawing community map is a useful and exciting PE tool. It is often a good technique to start with, as it attracts the attention of several participants and can stimulate much enthusiasm in the discussion. Mapping is able to reveal the spatial distribution of social amenities, presence and locations of arable crop farms and livestock grazing reserves as well as disease hot spots like live animal markets within communities. Participatory mapping can most importantly been used to trace both backward and forward foci of disease outbreaks. In this approach, respondents would be confident to indicate the locations and possibly the dates of clinical disease events and could also be able to describe the sequence of events that led to the index case and the pattern of diseases spread to next and even future locations in the livestock populations. This exercise can highlight key disease risk factors and very vital epidemiological information that would contribute to understanding disease transmission sequences [1, 9, 34, 35].

The application of participatory methods in project monitoring and evaluation

Recent developmental trends have brought participatory monitoring and evaluation (PME) to the fore. Developmental partners are able to interact directly with the communities to evaluate impacts of project intervention. National and international donors have found PME to be effective in empowering local communities, assessing and justifying project expenses to prove that services provided to such communities are worthwhile [37].

Application of participatory methods in community project planning

The processes of information gathering, problems identification and analyses in community developmental projects are best achieved by the use of participatory community planning tool. Communities' own initiated action planning is freely and directly communicated with the developmental partners for proper intervention [37].

The role of gender in the analysis of participatory studies

In communities, division of labour and different tasks undertaken by men and women exist. Gender role analysis is another PRA tool used in data collection that will help researchers analyse information and develop strategies to increase gender participation for greater developmental partnership. This approach increases the understanding and builds respective participating gender skills that are usually taken care during the planning exercise [38].

The application of timelines in participatory studies

Many livestock diseases occur as epidemics at finite time points and endemic diseases may come up at regular and irregular intervals. Timelines are a useful tool for exploring the frequency of key disease events and patterns over time. Concurrent occurrences of major events like drought or politics with disease outbreaks may assist participants easily remember the timing of key disease events and whether such events have influence on disease occurrence. Here local names of events should be used if possible. The dates of disease occurrence reported by participants can then be compared to official surveillance reports. Timelines were first developed with pastoralists to identify events that occurred before, during, and after an outbreak. First participants identify events of their own, choosing before being guided to identify specific events related to disease outbreak, such as onset of heavy rains, upsurge in mosquito populations, and occurrence of the first and last cases of livestock diseases. Finally, participants could be asked to identify the timing of any disease control interventions they witnessed and to identity the organization providing such interventions.

Benefits of using timeline in PE include:

a. Helps to clarify the details of disease events mentioned since respondents seem to better remember events that happened before or during disease outbreaks.
b. It often prompts respondents to remember additional information in disease events.
c. Helps to estimate the frequency and duration of disease events.

d. Shows the cause-and-effect relationship between events.
e. Enables surveillance team to involve communities in evaluating targets and disease control interventions [1, 23, 29, 35, 36].

The importance of transect walk in participatory surveys

The study of agro-ecological zones can be facilitated by two main techniques: agro-ecological transects and field plotting. Transect is simply a cut-across section of a territory where fields can be mapped, practices observed and boundaries of agro-ecological zones defined. In PRA, transects refers to the process of getting out and walking a straight line right trough a community deviating only when obstructions prevent direct passage to the opposite side. The idea is to directly observe production systems and community life. It is recommended that the appraisal team be accompanied by the community members. In this process, detailed notes of natural vegetation and field sketches are periodically taken, and farmers interviewed where possible. In a pastoralist set up, quality of grazing lands, soil type, vector habitats and prevalence of toxic plants may be observed [1, 33]. It is popularly said that a wealth of information is available to a relaxed observer that takes the time to look around [1].

The use of seasonal calendars in participatory surveys

Seasons are defined by different characteristics in different regions or even communities. It is important to be familiar with local terminology of seasons and how this relates to the months of the year in a community. Many livestock health problems and issues are seasonal and can be viewed through the use of calendars [1]. Seasonal calendars (SC) are used to visualize seasonal variations in disease occurrence or vector populations. It is more informative where local names of seasons are used with local names for diseases and vectors [20]. To construct a seasonal calendar, the first requirement is to determine what type of calendar is used in the local culture (lunar, Gregorian, etc) and then name the months in order. A horizontal line is drawn and divided into 12 months. Participants can be asked to indicate the relative rainfall during different months using counters across the timeline. The participants may on the alternative be asked to divide the year into different seasons paying attention to the characteristics of each season. If seasonal diseases exist, there relative occurrences should be indicated using counters at different points along the line of seasons mentioned. Key risk factors such as rainfall, humidity, vector populations etc in relation to disease incidence should also be noted. At the end SC provides relevant information on seasonality, identifies important predisposing factors to endemic diseases [1]. Season's measurement of age-specific disease incidence using local disease names and local definitions of livestock age groups is also possible with this method [20, 22, 36].

The Concept and Practice of Participatory Disease Surveillance

Participatory disease surveillance investigates disease occurrence using both primary and secondary sources of data and therefore features as a form of active clinical as well as passive surveillance approaches [7]. In the first instance, it engages communities in disease detection through dialogue and by conducting transect walk gives preference to clinical case detection and sample collection for specific

laboratory confirmation. In this regard, PDS is seen to be an active search for the presence or absence disease as well as unveiling events associated to disease outbreak and spread. It simply does that using traditional disease knowledge networks that can inform disease pattern across a community over time. Being a sensitive disease detection mode, it could project possible changes in the pattern and number of cases so that appropriate capacity is mobilized to respond to disease changes [7]. In the actual sense, PDS has increased not only the number of cases detected during surveillance but also the knowledge of the disease risks factors. This has assisted in detecting and tracking different diseases including rinderpest in East Africa, *peste des petits ruminants* in Pakistan and Central Asia, Rift Valley fever in Kenya, highly pathogenic avian influenza in many countries and foot and mouth disease in Pakistan [1, 9, 35]. PDS has also been very helpful in detecting emerging diseases that have been under-reported in neglected communities [7, 17, 22, 28, 36]. Recently, strong participatory programmes were established the status and demonstrate freedom from HPAI and rinderpest in Asia and Africa [9, 10].

Why Integrate Participatory Disease Surveillance into National Disease Surveillance

A comprehensive review of animal health surveillance needs assessment is pertinent for veterinary authorities to identify gaps in any existing surveillance system so that workable objectives are established. This information can then be used to select an appropriate combination of surveillance activities that best meet these objectives and the information needs. In this respect, Thacker provided performance criteria for an adequate design and evaluation of effective surveillance systems [1, 9, 35]. Major considerations include the cost, the efficiency and sustainability of each surveillance system to achieve the set objectives. Many experiences have shown that the appropriate incorporation of participatory methods into surveillance efforts would enhance the effectiveness of surveillance by increasing the rate and timeliness of outbreak detection [7, 9, 35].

Participatory animal disease surveillance focuses on the needs and priorities of livestock farmers. It creates within the community veterinary service that is customer-driven which helps to improve relationship between livestock keepers and animal health service providers so that disease surveillance is made easy. Compared to conventional approaches, PDS is more cost effective in terms of the cost per outbreak detected [7, 9, 35]. However, passive disease surveillance using PDS may be more expensive to sustain if disease investigation requires that practitioners must continuously visit farmers to obtain further information. Furthermore, PDS helps to minimise costs and increase sensitivity of case detection by targeting the areas of highest risk for diseases in focus [7, 17, 28, 36].

For countries that may decide to include participatory surveillance methods in their national disease investigation system, such a country should first invest in the training of PDS practitioners who are able to extend surveillance activities into remote areas throughout the country [7, 22, 36]. This is because training large numbers of enumerators and surveillance officers to serve throughout local communities may suffer from inconsistencies and dilution of data enumeration leading to a reduction in the quality of surveillance data [7].

In conclusion, PDS is believed to be an innovative approach that can lead to enhanced animal health surveillance system. It has also been proven to be effective in terms of disease detection, monitoring and communication because of collaborative efforts between professional researchers and communities. On these bases, participatory approaches have now been given due disease surveillance credit when solely utilized in outbreak detection and in some situations when used to complement the conventional methods to aid more effective surveillance [7, 9, 35, 57, 58, 59].

Other uses and applications of participatory epidemiology

Rural appraisals are generally applied in the diagnosis of rural issues. They are very useful in project implementation, transfer of technology, project monitoring and evaluation, policy reform and emergency response to disasters to improve already existing methodologies [23]. Interactive research is useful in developmental projects that involve public health, agriculture and socio-cultural activities [33]. Earlier, PE focused on needs assessment to establish community-based animal health interventions [4]. Participatory epidemiology evolved to be utilised in disease surveillance primary data collection as well as local developmental programmes where the participants get involved in formulation of an action plan to improve animal health and productivity. Where researchers are deficient in local traditional contexts, qualitative information would rather be misinterpreted. However, participatory methods would contribute to data clarity and subsequent acceptance. Consequently, field epidemiologists realised that there was tremendous potential to develop participatory approaches in scientific researches, disease outbreak investigation and surveillance both rural and urban communities. It is concluded that strategies allowing intensive dialogue between researchers and the researched would generate better outcome than a conventional non-interactive approach [22, 23, 36]. Participatory technique in disease surveillance is aimed to ensure that surveillance is sensitive and conducted within an expected timeframe so that a high percentage of significant field events are detected and investigated [7]. Participatory epidemiology use in disease eradication can also be used as a sensitive tool to confirm the presence or absence of clinical cases. Goodman and Buehler [38] further defined interactive field disease investigation as the practice of epidemiology in response to real and time-bound problems that would require a rapid response. Until the late 1990s, veterinarians and epidemiologists in government, academia and research centres viewed interactive inquiry as a non-stress approach practiced by social scientists which lacked scientific bases of conventional scientific research [39]. Today PE presents as distinct appraisal type research that is associated with more refined methods and involves key stakeholders to provide more valid interpretation of local information on diseases. Relatively simple statistics are used in the field to present and discuss results with the participants that could progress to further insights and clarifications for easy acceptance and feedback [20, 39, 40]. Results are visually presented in simple charts that illiterate people could also contribute to community research.

Results

Existing veterinary knowledge in the communities

Evaluating the existing veterinary knowledge (EVK) using SSI revealed the use of these plants *Solanum nodiflorum* and *Momordica balsalmina* to treat ND in all the villages visited. Farmers believed that ND occurred year round with higher incidences during cold windy and dusty hamatan. SSI further revealed that ND outbreaks in rural poultry almost always followed introduction of new birds into existing flocks. Also, some communities were of the opinion that ND could be transmitted via human and dog faeces if poultry feed on them. Also, ectoparasitism in poultry was most common during the dry season and preen gland inflammation in ducks was responsible for leg weakness and ventral recumbency. Guinea fowls were reported to suffer severe ND outbreaks during the period of comb eruption. In Katsina state Nigeria, "firing" of hygroma lesions observed in cattle brucellosis, and drenching infected animals with *Senna occidentalis* (rai dore) could effectively control brucellosis in some rural communities [17, 36].

Livestock populations and risk factors to livestock diseases

Semi-structured interviewing of livestock farmers' focus groups revealed that livestock species kept in Bauchi and Gombe states included poultry, goat, cattle, sheep, and pig in order of decreasing population. These animals were mainly managed extensively with little or no veterinary care and feed supplementation. Proportional piling indicated the median scores (95% CI) of the relative proportions of livestock kept in selected villages of Bauchi and Gombe States where 52.8% poultry, 37% small ruminants, 5.8% cattle and 0.5 pig. Major constraints to livestock production included periodic shortage of feed (March to July), lack of watering points (during the dry season) and livestock disease burden that appeared all year round with sporadic higher incidences (December to February in case of ND) as indicated by participating farmers. This finding is similar but with little variation in Katsina state where poultry form 70% of livestock population, however, sheep and pigs were not kept in the rural communities.

Table 3: Mean and median scores (95% CI) of the relative proportions of livestock species kept in selected villages of Bauchi and Gombe States, Nigeria determined through proportional piling exercise.

	Local Government Area		Relative livestock populations			
State		Village				
			Poultry	Sheep/goats	Cattle	Pigs
Bauchi	Bauchi	Fadaman	57 (54-60)	40 (37-43)	1 (0-4)	0 (0)
		Wunti	52 (49-55)	33 (30-36)	1 (0-4)	0 (0)
	Misau	Luggudi	58 (55-61)	35 (32-38)	5 (2-8)	0 (0)
		Legal	50 (47-53)	41 (36-42)	8 (5-11)	0 (0)
	Katagum	Madangal	52 (49-55)	35 (32-38)	11 (8-14)	0 (0)
		Kakimari	49 (46-52)	48 (45-51)	2 (0-5)	0 (0)
		Mean	53.0	38.7	4.7	0.0
Gombe	Gombe	Pantami	56 (53-59)	42 (39-45)	1 (0-4)	0 (0)
		Malam inna	53 (50-56)	36 (33-39)	8 (5-11)	0 (0)
	Yamaltu deba	Deba	49 (46-52)	33 (30-36)	9 (6-12)	2 (0-5)
		Kwadon	60 (57-63)	33 (30-36)	5 (2-8)	0 (0)
	Kaltungo	Kalaring	48 (45-51)	32 (29-35)	8 (5-11)	3 (0-6)
		Ture-mai	49 (46-52)	36 (33-39)	10 (7-13)	1 (0-4)
		Mean	52.5	35.3	6.8	1.0
		Overall mean	52.8	37.0	5.75	0.5

Economic importance of livestock species in the communities

Results of economic importance of different livestock species is shown below. Cattle is the most important source of income (9 scores) in the communities. It is the most important (6 scores) source of drought power, contributed second (3 scores) to goat (4 scores) to source of milk for human consumption and contributed equally (6 scores each) to fertilizer for crop farming. Poultry was however, the most important source of gift to friends and visitors (11 scores), unfortunately poultry was not kept for its eggs (0 score) in the communities evaluated.

Important poultry diseases and how famers recognize them in the studied villages

Conduct of proportional piling to evaluate important poultry diseases was shown in Plate VII. Highly pathogenic avian influenza was never mentioned as a problem in poultry in all the visited villages. However, SSI targeting HPAI indicated its poor identification by farmers (10%) because most (80%) farmers believed that HPAI was the same with ND.

The result of matrix scoring for major poultry disease definition as recognized by farmers in the study areas. Newcastle disease was recognized by farmers by high morbidity (18 mean scores) and mortality (20 mean scores), nervous signs (27 mean scores), respiratory distress (27 mean scores), and greenish (28) to whitish (27) diarrhoae. Bloody diarrhoae was a mojor (28 mean scores) feature of coccidiosis while nodular lesions (27 mean scores) charecterised fowl pox (Table 4.22). The Kendels' coefficient of concordance (W) established strong agreement with the clinical attributes associated as observed by farmers (W = 0.5-0.9) (Table 4.22)

Table 4: A summary of matrix scoring (by proportional piling of 30 counters each) of major poultry diseases versus clinical manifestations as reported by rural poultry farmers in seven selected villages of Bauchi and Gombe States, Nigeria

Clinical attributes	Diseases			
	Newcastle disease	Coccidiosis	Fowl pox	Ectoparasitism
High morbidity (W = 0.83)	18 (15-21)	3 (0-6)	3 (0-6)	8 (5-11)
High mortality (W = 0.90)	20 (17-23)	8 (5-11)	1 (0-4)	1 (0-4)
Nervous signs (W = 0.83)	27 (24-30)	0 (0-0)	0 (0-0)	3 (0-6)
Respiratory distress (W = 0.90)	27 (24-30)	0 (0-0)	2 (0-2)	1 (0-1)
Greenish diarrhoae (W = 0.51)	28 (25-30)	1 (0-1)	1 (0-1)	0 (0-0)
Bloody diarrhea (W = 0.54)	2 (0-2)	28 (25-30)	0 (0-0)	0 (0-0)
Whitish diarrhoae (W 0.90)	27 (24-30)	0 (0-0)	0 (0-0)	2 (0-2)
Papules/nodules (W = 0.54)	0 (0-0)	0 (0-0)	27 (24-30)	2 (0-2)
Insects on the body (W = 0.83)	0 (0-0)	0 (0-0)	2 (0-2)	2 (0-2)
Decrease productivity (W =0.90)	15 (12-18)	6 (3-9)	7 (4-10)	2 (0-2)
Vector associated (W = 0.83)	2 (0-2)	0 (0-0)	6 (3-9)	22 (19-25)

Vaccination impact on morbidity, mortality and case fatality due to Newcastle disease

Assessing ND vaccination impact in a focus group of poultry farmers in Luggudi village revealed that the mean annual morbidity, mortality and case fatality rates of 95%, 78%, and 82% respectively were expected if there was no ND vaccination. If vaccination against ND was done, however, the morbidity, mortality and case fatality rates were evaluated to be lower 55%, 10% and 18% respectively.

Table 5: Overview of veterinary information collected using participatory epidemiology methods.

Method	Information
Informalinterviews	
Semi-structured interviews	Used in most PE studies and in combination with visualization, and ranking and scoring methods; also used as a stand-alone method [33, 40, 41, 43]
Timeline	History and timing of disease events [42, 43, 54]
Visualizationmethods	
Participatory mapping	Livestock movements with respect to the location of grazing areas and water points [44]. special exposure to disease vectors
Seasonal calendars	Seasonal variation in disease incidence [40, 37, 38]. Seasonal variation in human livelihoods e.g consumption of livestock products and livestock trade [42, 43, 44, 45]. Seasonal variation in contact with disease vectors, neighbouring livestock and wildlife [39]. Seasonal variation in vector populations [47].
Proportional piling	Age structure of livestock herds [22, 46]; disease incidence and mortality estimate by age group [51]; impact of vaccination on livestock mortality [49]; case fatality rates [36, 49] Relative livestock proportion [22, 31, 36] Poultry disease profiling [28] Livestock disease profile [31, 36].
Radar diagrams	Analysis of control strategies [40].
Rankingandscoring	
Simple ranking	Analysis of disease control [39]; priority of livestock diseases [50].
Matrix ranking	Analysis of disease control [38].
Matrix scoring	Local charecterisation of clinical signs and causes of disease [51, 52]. local charecterisation of disease vectors [45]. comparison of clinical diagnoses of livestock keepers and veterinarians [53]. analysis of veterinary service providers [54], economic and poverty impacts of animal diseases [55], Impacts of ND [31].
Before-and-after scoring	Impact of veterinary services on the livelihoods impact of disease [54]. Incidence and impact of livestock diseases on livelihoods [31, 48, 57]

Adapted from [5] and updated.

Discussion

Participatory rural appraisal evolved out of RRA and was used in project design and monitoring because it was shown to be timely, accurate, cost-effective means of collecting essential information for project formulation and placed more emphasis on community empowerment to process and utilise information generated [18, 19]. The researcher shifts from being primarily an ‘extractor’ of information to a facilitator of community development and livestock owners played active intellectual roles in community projects [20]. Today PE uses interactive techniques of PRA to harvest qualitative epidemiological information within community observations, EVK and traditional oral history [21]. In this approach, due considerations are given to the needs and priorities of livestock producers thus PE adjusted the already established delivery system of veterinary services of a “top-down” to a “bottom-up” approach. The participation of livestock stakeholders in surveillance system ensures that the system is responsive to stakeholders’ needs and increases farmers’ sense of commitment towards sustainance [7.]. A rural research using PE conducted in the Jos Plateau, Nigeria showed the profile of common poultry diseases and consequently achieved a strategic government intervention of massive Newcastle disease vaccination of rural poultry [22].

When social scientists where involved in scientific research projects in the 1980s, many projects led to the development of professionals that understood rural socio-cultural conditions and made indigenous technical more popular. Rural people were seen not ignorant and could make important intellectual contributions to development [4, 17, 18, 21].

PE data are collected and recorded as non-numeric, non-categorical testimonies, explanations and interpretations by the participants. The quality control of the data was practiced and data could be transformed into quantitative information at several points using several participatory methods of ranking and scoring. The investigator could compare and contrast information from different sources in order to judge its merit through the use of multiple validating methods termed *triangulation*. If the multiple information sources and methods converge on a consensus or near consensus view, the investigation has a qualitatively significant outcome to reach the best and full understanding of disease ecology [24, 25]. This has fortunately led to a considerable increase in the number of PE activities and practitioners in Africa, Asia and Europe [26].

Existing veterinary knowledge helped the Maasai community to avoid exposing their cattle to wildebeest during wildebeest calving seasons because it was believed to be an enhancing factor to the spread of malignant catarrhal fever in cattle. Plowright [15] reported that nomadic cattle owners could give professionals a firm diagnosis of rinderpest, used discharges from mild forms of rinderpest to immunise their young stock. Communities in Trinidad accurately predicted epidemic periods of yellow fever based on observations of red monkey mortality [16]. Surveys using EVK became an important method for the identification and prioritisation of animal health problems within rural communities. In the recent years, we reported the uses of “firing” and *Senna occidentalis* (rai dore) to effectively control brucellosis in some rural communities in Katsina state, Nigeria [17].

Musa et al. [36] used PP to evaluate the relative livestock populations and assessed the status and impacts of Newcastle disease in some rural communities in Nigeria. The research concluded that it was best to conduct the exercise with a smaller group than larger ones. Discussion and probing of the results of the PP provided more information on the final score because the respondents gave the scores and more information about how they viewed the results [1, 35]. In the study, poultry was ranked top most in most villages (73%) followed by goats (13%) and cattle (13%). Probing technique revealed that there was hardly any house without at least a chicken in these farming communities. The ease of management and low inputs involved in the extensive management of rural based poultry and small ruminants could be some of the reasons for their high populations in the 30 villages surveyed. Sonaiya [60] in 1999 reported that poultry for long has been of value as a source of emergency fund, has been of great use in festivities and spiritual celebrations and were also offered as gifts to friends and visitors in many rural communities. So the position of poultry in this research finding made it easy to evaluate major constraints to poultry keeping. Disease was ranked highest among the constraints to poultry production, and losses due to ND outbreak were most important to poultry in the all the villages studied. Newcastle disease has been documented as being worldwide in distribution, was associated with unexpected mass morbidity and mortality that its impact is appreciated by almost every poultry farmer [61]. Newcastle disease is well

known by poultry farmers so much so that it is given local names and associated with varying believes in many traditional settlements worldwide [22, 60-62], these findings supported the significant position of ND in this study.

The results of matrix scoring showed that farmers usually recognise ND by nervous signs, whitish diarrhoea, high morbidity and mortality which agree with some established literature [63-65]. In many literatures however, greenish diarrhoea especially in acute ND infections supercedes the white diarrhoea reported by farmers [64, 65]. This means that farmers may lack the ability to recognize acute ND that may not be associated with the normal nervous signs and high mortality and most especially may lack the ability to recognize HPAI therefore limiting their ability to report suspected cases. Matrix scoring further made it possible to evaluate certain disease syndromes like *'makere* (somnolence), *fakat* (massive death), and *farin kasha* (white diarrhoea) *'* to mean ND as understood by the Hausas and this seems to agree with the clinical presentations of ND as existed in many scientific findings on ND [66, 67]. In villages where vaccination against ND was common, morbidity and mortality due to ND outbreaks was assessed to be lower (18%) as compared to what was observed with ND morbidity (95%) and mortality (78%) rates in unvaccinated poultry flocks and this seems to agree very well with the existing facts on ND [67, 68]. From this study ND appeared year round with seasonal variation of higher incidences during the cold dry windy period and at crop harvest time (*kaka*). The importance of seasonal calendar of diseases is to inform policy makers to decide strategic control interventions and where applicable, it further shows how vector control can be feasible [1, 4]. Existing veterinary knowledge and SSI revealed some level of herbal use to treat livestock disease in the studied villages. The commonest herbs that were used in treating ND included *Solanum nodiflorum* and *Momordica balsalmia*. *S. nodiflorum* is soaked in poultry drinking water. Though the farmers claimed these wild fruits treat ND, scientific investigation of these fruits will authenticate the farmers' belief. According to Nwude and Ibrahim [69], *S. nodiflorum* was useful in the treatment of worm infestation in poultry, sheep and goats. Ethno-veterinary management of ND was reported to be common in rural poultry in Nigeria and Cameroon where Veterinary extension services are scarce [70, 71].

Farmers further claimed that human and dog faeces from people and dogs that have consumed ND infected poultry could be responsible for ND outbreaks, and this seem to agree with the observation that animals like dogs, cats, foxes and rodents shed ND viruse for as long as 72 h after consumption of ND infected fowl carcasses [72]. In addition man was also reported to be infected and shed ND virus [73].

There has been an increased awareness of the importance of preserving traditional medicine, and efforts are being made to integrate orthodox and human traditional medicine which unfortunately is not quite appreciable in veterinary medicine [69]. Therefore, PE and especially EVK showed a lot to be appreciated from rural farmers.

Cattle appears to be the most economically important livestock kept in the communities visited because of its significant contributions to income, source of fertilizer, milk and drought power despite the fact that it is the third populated livestock specie. This means any intervention to improve the health and productive status of cattle will be highly appreciated by the communities. Notwithstanding poultry being the most

populated animal species is of significance in strengthening relationship as it plays vital roles in festivities and gifts to friends and visitors. Unfortunately, the opinion that poultry keeping can bridge protein deficiency gap in many developing nations due to consumption of egg may only be a nightmare as this results showed that poultry are not kept for routine egg consumption in rural communities but the interest of the farmers is majorly for the expansion of their flock sizes so that poultry is adequately utilized for gifts and festivities.

Conclusion

There is the need to always understand farmers' priorities in livestock health surveillance and control for a sustainable livestock health policy intervention. Based on sensitivity, timeliness reliability of data generation and broad application, participatory health investigations should be incorporated into national disease surveillance system to enhance validity of data and to better appreciate the epidemiology of livestock diseases.

Abbreviations

CAHW-community animal health worker, EVK-existing veterinary knowledge, FGD- focus group discussion, GPS-global position system, HPAI- highly pathogenic avian influenza, MS- matrix scoring, PE- participatory epidemiology, PDS- participatory disease surveillance, PP- proportional piling, PRA- participatory rural appraisal, PWR- pair-wise ranking, RRA- rapid rural appraisal, SC- seasonal calendar, SR- simple ranking, SSI- semi-structured interview, TL- timeline, TW- transect walk.

Declarations

Ethics approval and consent to participate: The Ahmadu Bello University Ethics Committee on Animal Use and Care was established in 2016 with the mandate of ethical consideration in research involving animals. This study was carried out in 2014/2015 and had no relevance to animal experiment. However, community and opinion leaders were contacted prior to the study. Informed consent to participate in the study was verbally obtained from the community leaders and participants.

Consent for publication: Not applicable.

Availability of data and material: Authors' original research data and duly acknowledged data from the literature were used.

Competing interests: Authors declare none.

Authors' contributions: Authors participated in the design and conduct of the study, and drafting the manuscript.

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Figures

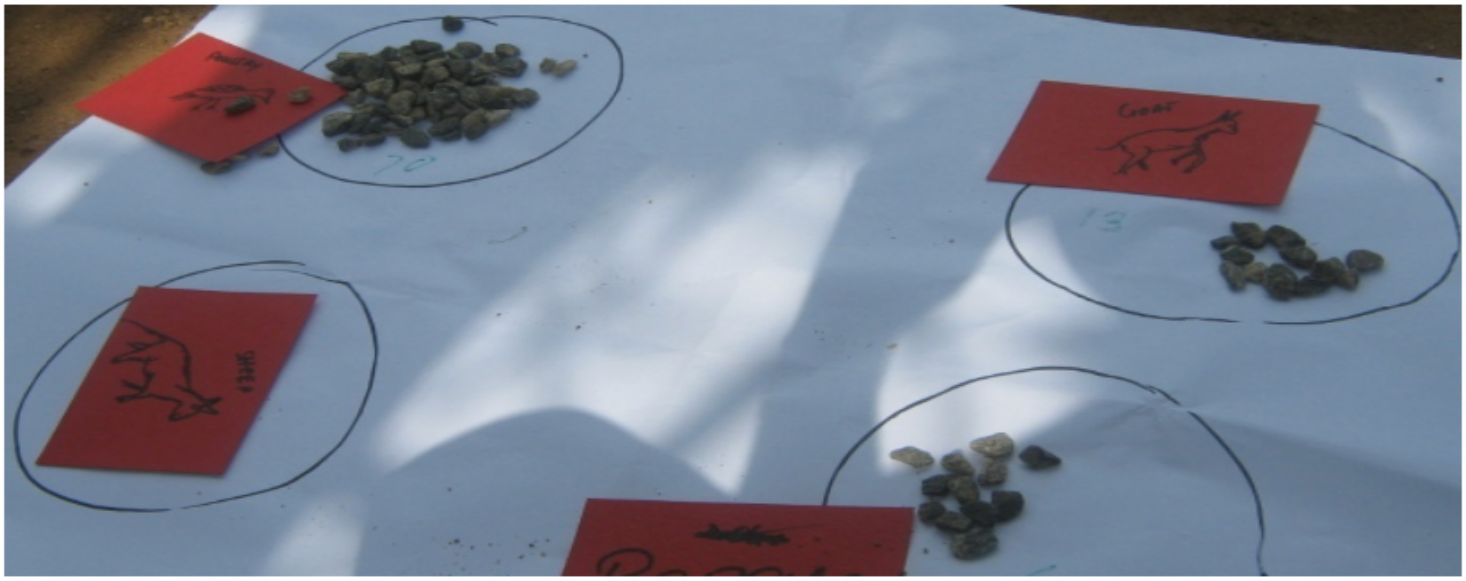
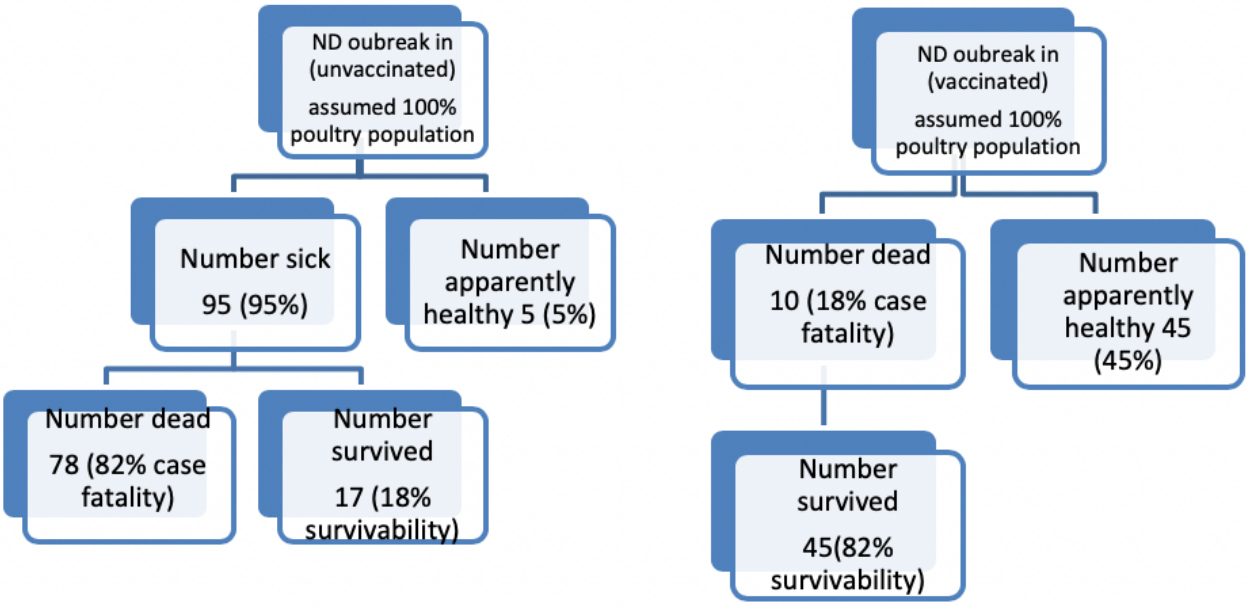


Figure 1

Proprtional piling showing relative livestock population in a Katsina state rural community [17]

Figure 2

Matrix scoring results showing the economic impact of most important livestock species kept in a rural community in Nigeria [36].



A B

[36].

Figure 3

Participatory assessment of ND vaccination impact in unvaccinated naïve (A) and vaccinated (B) poultry flocks in Luggudi, Bauchi State [36].