Chapter 11. Measuring public attitudes to releases of transgenic mosquitoes for disease control

11.1 Introduction

Since their commercial application a few decades ago, GMOs have been highly controversial with vocal opponents in both developed and developing nations.[1,2] This was particularly apparent in 2002 when Zambia rejected food aid from the USA during a famine on the basis that it was GM.[1] More recently, regarding GMMs, vocal opposition in Malaysia has led to releases of GM *Aedes aegypti* – the mosquito species that transmits dengue fever – being delayed,[3] and the announcement in the Cayman Islands of an open field trial of GMMs was met with controversy.[4]

However, vocal opposition is not always representative. The potential use of GMMs to control dengue fever in Key West, Florida, USA, illustrates this point. In 2011, a town hall meeting on the subject was met with resistance and an online campaign to prevent the intervention.[5] However, two recent surveys of residents in the region found that the majority of respondents actually support the intervention and consider it safer than the use of chemical insecticides.[6,7] In a democratic society, it is essential that we obtain a representative sample of attitudes in order to inform scientific and policy-related decisions. In addition to informing political decisions, surveys of public attitudes lead to information exchange with community members and contribute to how disease control programmes are implemented.[8]

In this chapter, the author describes experience with measuring public attitudes to the use of GMMs in Africa and outlines how descriptive surveys can be used to inform the design of quantitative ones.[9] The chapter is based on a descriptive survey of public attitudes to GMMs for malaria control in Mali, West Africa, with a team of Malian doctors and scientists in 2008 and 2009.[9] Qualitative surveys like this one are useful because they provide a detailed picture of the range of views that a population holds on a certain issue. However, they only provide a crude idea of how common these views are in the population. This information is better provided by quantitative surveys, the design of which is well informed by initial qualitative studies (Table 19). The chapter continues by describing the design of quantitative surveys and the types of questions that a quantitative survey should include.[10] Finally, a summary of surveys of public attitudes to GMMs that have already been conducted,[6,7,9,11] and opportunities for further work preceding a potential transgenic release in Africa are presented.

Table 19. Pros and cons of qualitative vs. quantitative surveys

	Qualitative surveys	Quantitative surveys
Pros	Allow for freedom and spontaneity in responses	Fast and less costly
		Well-suited to group comparisons
	Provide a deep understanding of how respondents think	Allow a large number of respondents to be interviewed
Cons	Time-consuming and costly	Lack the spontaneity and freedom of qualitative surveys
	Only a small number of respondents can be interviewed	

CASE STUDY: A QUALITATIVE SURVEY OF PERSPECTIVES TO GMMS IN MALI

In late 2008 and early 2009, a group of Malian doctors and scientists and Marshall et al.[9] conducted a qualitative survey of public attitudes to GMMs for malaria control. Mali was chosen because it is the site of extensive research on the ecology of malaria vectors of relevance to GMM projects,[12] and because it is home to a range of ethnic groups, including the Bambara, Dogon, Peul, Songhai and Taureg. The team focused on malaria, because it is the most devastating VBD in sub-Saharan Africa; and on mosquito population replacement, because it is generally considered to be a strategy that holds great promise for malaria control.[13] In this strategy, a disease-refractory gene is linked to a gene drive system capable of spreading genes to fixation in one or many populations.[14]

The survey consisted of semi-structured interviews that lasted on average 45 minutes. Semi-structured interviews consist of a set of open questions, for which response options are not provided. They also incorporate a degree of flexibility, allowing new questions to be brought up depending on interviewees' responses. The series of open questions covered perspectives on mosquitoes, nature, heredity, diseases, genetic alteration, and acceptable conditions for a release of GM crops and GMMs for disease control into the environment. Since the majority of the population were subsistence farmers and were familiar with selective breeding, genetic alteration was described as "a faster way to develop more desirable animals, fruits and vegetables, but that this method could lead to unknown consequences for the environment." The full text of the survey is now available.[9]

Sample: For a preliminary descriptive survey, the best sample is a judgement sample, the goal of which is not to be representative, but to obtain as diverse a range of responses as possible. This helps to understand how people think about a topic and to formulate meaningful questions and response options.[15] A sample of 30–40 people is usually sufficient but, as a general rule, sampling should continue until no new ideas are obtained. For the descriptive survey in Mali, a judgement sample was used consisting of 80 people – 30 of various ethnicities in the district of Bamako, 20 predominantly Bambara in ethnicity in the region of Koulikoro, 10 predominantly Dogon in ethnicity in the district of Mopti, and 20 traditional and Western-trained health professionals in Bamako and the region of Mopti. In each group, men and women of a variety of ages and social statures were interviewed, thus satisfying the criteria for a preliminary survey.

Protocol: In each village or suburb, the team visited the local chief and decision-makers and explained the purpose of the survey to them and their desire to obtain a diverse sample. The chief met the elders to discuss the survey, and they

selected the participants together. The chief generally offered to be the first participant, and a young guide escorted the interview team from one participant to the next. Questions were posed by a local Malian (translator) and other members of the interview team posed the follow-up questions. The responses were then translated, transcribed and recorded to check for errors. Participants were offered a confidential setting to respond to the questions, however, most participants appeared comfortable in a common setting with friends and relatives surrounding them. Ethical approval was obtained from the institutional review boards of the Malaria Research and Training Center (Bamako, Mali) and the University of California (Los Angeles, California, USA).

Results: The collective responses of the 80 survey participants provided interesting insights into many issues surrounding the GMM project – from nature and heredity, to conditions for a release of GM corn and mosquitoes. Awareness of the fact that mosquitoes cause malaria was widespread, with 80% of participants citing mosquitoes as at least one main cause of malaria. This is captured by the following statement from a woman in Banambani: "When a mosquito bites, it can then bite another person and carry blood from the first person to the second person. This is how malaria is transmitted." However, a number of other causes were often cited in conjunction with mosquitoes, including mangoes, sugar, oily foods and exposure to the sun or cold weather. Mosquitoes were also singled out as nuisance creatures which can be killed without problem; however one respondent pointed out that insects are a possible object of sorcery referred to as the "korote": "It's a missile, but it's also an insect. They can fire it from one place and it will get you in your home." This highlights the importance of studying cultural symbols and beliefs prior to a transgenic release.

With most of Mali's population being involved to some extent in subsistence farming, understanding of selective breeding and a modest awareness of the controversies surrounding GM crops was useful in explaining the concept of GMMs for malaria control. Selective breeding was stated as being practised on various animals, crops and trees. Most respondents considered heredity to be caused by both blood and God, as captured by the following statement by a man in Koulikoro: "There are two reasons for offspring resembling their parents – first, if you have the same blood then it is expected that you will look alike; and second, this [resemblance] is due to God." Only six of the 80 participants referred to genetics, although several were aware that neighbouring Burkina Faso had recently accepted to release GM cotton into their environment for commercial farming. As a woman in Bamako stated: "The politicians in Burkina Faso made a decision about growing GM cotton without consulting the population."

One of the most illuminating questions regarded perspectives to a hypothetical release of GM corn that promised higher yields due to an engineered insect-resistance trait. The majority of rural respondents requested a trial be performed to confirm the crop's beneficial consequences and lack of negative consequences prior to a large-scale release. Some were very specific about the details of their proposed trial. As one respondent described: "I would choose a different space to culture the new crop, about one to two kilometres away from my farm. I would like this area to have the same area as my farm to provide a good comparison. Afterwards, I would collect the corn from the two farms and would see which produced the better yield." A trial period of one season was suggested and participants pledged to monitor the effects of GM corn on human health during this period.

The concept of a trial was extended to GMMs. Participants were asked to imagine that an organization from a foreign country could provide a GMM capable of reducing malaria in their community, that there were no known negative consequences, but that unknown consequences could not be ruled out. Most participants said that they preferred that the trial be conducted in another village before accepting a release in theirs. However, a few preferred that the first trial be conducted in their village. One man from Mopti stated: "You have to start somewhere… I would like you to

conduct a trial in my village because I would like to be an example for another community." In addition to a successful trial, respondents had a number of additional requirements for a release of GMMs in their community. These included an education campaign, the provision of bednets, and prior approval for the release from a majority of the community. The main concerns were that the project would not work, resulting in a net increase in malaria-transmitting mosquitoes, or that the GMMs would transmit other diseases, such as HIV or a new strain of malaria. These responses are highly informative for technology development, trial design and future quantitative surveys.

11.2 Conducting a quantitative study

Quantitative surveys are, in a sense, complementary to qualitative surveys – they consist predominantly of closed questions, for which a limited set of response options are provided. They are faster and less costly, and therefore allow a large number of respondents to be interviewed. They also provide a good idea of how prevalent certain views are in a population and how these views differ between groups (age, gender, etc.).[16] Their major weakness is that, due to their closed nature, they are not suitable for elucidating the range of views held by a population on a certain issue (Table 20). This is why a successful quantitative survey always precedes a qualitative one. It allows researchers to identify general themes, formulate meaningful questions, and enumerate a near-complete range of responses for the population of interest. The following sections describe how a series of closed questions can be developed beginning with the results of the qualitative survey described earlier. In general, this process will involve the following steps.

1. Identify the population of interest and generate a sample
    a. Identify the full set of individuals whose attitudes you wish to quantify
    b. Draw a sample from this population such that each individual has an equal chance of being selected.
2. Conduct a preliminary qualitative study
    a. Identify themes
    b. Formulate meaningful questions and response options.
3. Design the questionnaire
    a. Write a series of factual, opinion and attitude questions based on the preliminary results.
4. Pilot the questionnaire
    a. Test and improve the questions to ensure that the questions are informative.
5. Conduct the survey

11.2.1 Step 1: Identify the population of interest and generate a sample

The first step in any study is to identify the population of interest. This is the full set of individuals whose attitudes we wish to be quantified, e.g. all Malian citizens 18 years or older living in Mali at the time of the survey. It is not possible to interview our entire population, so we must choose a sample. A completely random sample in which every individual is randomly selected is not feasible in Mali because respondents must be visited individually, and sampling from the entire country would be prohibitively expensive. The best alternative is cluster sampling, which takes advantage of the geographical structure of a population and applies the principle of probability sampling to each stratum sequentially.[17] Attitudes to biotechnology have been measured in this manner in Europe.[18] In Mali, a random sample may be difficult to achieve at the community level because random sampling is inconsistent with the village hierarchy; however, a careful explanation of its purpose may make it acceptable to the chief and elders. The aim should be to achieve as random a sample as possible while being respectful of local cultural etiquette.

In other settings, different sampling methods may be appropriate. In countries where almost everybody owns a telephone or is accessible by mail, random sampling is possible. Attitudes to biotechnology have been measured in this manner by telephone in Japan, New Zealand and the USA[19,20] and by postal questionnaires in Japan[11,21] and Florida.[6] An electoral register or telephone book may be used as a sampling frame. In Florida, USA, a list of addresses was purchased from a survey sampling company.[6] Another option is quota sampling. In this case, a sample can be artificially engineered to have the same demographic qualities as its parent population. In general, the demographic qualities of a sample and parent population can be compared to check for sampling errors.

A number of methods are available for sampling people at the community level, depending on the time and resources available (these methods can also be tested during the piloting phase of the survey). In one method, the coordinates of all households are initially recorded using global positioning system (GPS) units, and a software package is used to determine the optimum route for survey teams to take through the community.[22] Eligible respondents in each household can then be chosen at random, for example by selecting the eligible respondent who most recently celebrated their birthday.[6] A return visit should be arranged if this respondent is not available on the first visit. This method generates a robust random sample; however prior GPS mapping, visiting and re-visiting can be time-consuming. If resources are limited, another standard randomization technique is to begin at the centre of a suburb or village and for each interviewer to choose a direction to work through by spinning a pen on a flat surface. The interviewer then walks in this direction and interviews a person from every *n*th household, where *n* is a random number between two and five chosen at random for each interviewer at the start of the survey. This method is less time-consuming, allowing many more individuals to be sampled in a short time, but is less robust than the GPS method.

Sample size: Finally, the sample size is always a compromise between theoretical requirements (accuracy) and practical considerations (costs). Calculations can be performed to determine the sample size required for an acceptable error. A simple yes/no question with a sample of 3000 people, for example, will produce a standard error of less than 1%. The importance of an accurate sample should be stressed, since a large sample size cannot make up for poor sample design.

11.2.2 Step 2: Conduct a preliminary qualitative study

As already discussed in the section on the Mali case study, a quantitative survey should always be preceded by a preliminary study to understand how people think about a topic. This assists in the design of meaningful questions and response options.[15] Previously, we described how a qualitative survey could serve this role by using a semi-structured interview structure and a judgement sample to obtain a diverse range of responses. Another option is a focus group study. These are group discussions led by a trained moderator who ensures the participation of all group members.[23] For focus studies, group members should be chosen with the goal of obtaining a diverse range of opinions on the topic in question. The advantage of these studies is that they are more efficient at enumerating themes and the range of responses than individual interviews, which can be a lot more time-consuming. However, the two study types are not mutually exclusive, and a combination of the two can be used preceding a quantitative survey design.

In both cases, before conducting the interviews a series of topics should be prepared, but their order may change. The aim is to obtain deep responses on a topic with an emphasis on spontaneity. For the goals of a preliminary study, completeness is not necessary – it is better to obtain rich data on a few topics than superficial data on every topic, since different respondents will provide rich data on different topics.

For the hypothetical survey of Malian citizens 18 years or older living in Mali, the descriptive survey illustrated earlier[9] would serve well as a preliminary study. But it would be good to supplement it by posing the same open questions to communities not covered in the original survey, e.g. communities that are predominantly Peul, Songhai and Taureg in ethnicity and among some of the other six regions of Mali. The same procedure should be followed prior to designing quantitative surveys in other countries. A judgement sample should be chosen and a series of topics prepared depending on national cultural beliefs, the disease of interest and the nature, scale and scope of the applicable GMM strategy.

11.2.3 Step 3: Design the questionnaire

Once peliminary studies have been completed and general themes identified, the first step in the design of a questionnaire is to decide on its aims. The purpose of the questionnaire proposed here is primarily to quantify the proportions of Malians that hold particular views toward GMMs; however a number of secondary hypotheses may also be investigated. For example, what are the social determinants of these attitudes? Are there differences between males and females, parents and non-parents, rural and urban dwellers, or decision-makers and ordinary citizens? Do attitudes correlate with age group, religious affiliation or level of education? Does a better understanding of malaria, heredity or genetic engineering lead to more positive attitudes to GMMs? Do attitudes to GM crops correlate with attitudes to GMMs, and which of these two are viewed more positively? Every question should have a clear reason for being included, and the team should know how it is going to analyse the results.

Questionnaire modules: An example of a quantitative survey designed from the results of the Mali descriptive survey is provided in Marshall et al.[10] This questionnaire is divided into four modules: (i) factual questions on malaria, heredity and GM organisms; (ii) attitude questions on GM crops; (iii) attitude questions on GMMs; and (iv) demographic information. The researchers chose this order based on the internal logic of the inquiry; however piloting can be used to reveal the optimal question order. For a spoken interview, as appropriate in Malian villages, the interviewer has some leeway in reading factual questions in order to offer explanations or correct misunderstandings. Attitude questions, however, must be read precisely due to their strong dependence on question wording.

A preliminary module on GM crops was included because the preliminary study found that this provided a gradual introduction to questions on GMMs. However, pilot studies could be used to determine whether this is necessary. Demographic questions can be placed either at the beginning or end of a questionnaire. If placed at the beginning, they serve as easy warm-up questions. However some surveyors prefer to place them towards the end of a survey so that respondents know what they are linking their information to.[16] For these questions, it is acceptable to probe respondents to ensure the correct information has been obtained. For more details on the questionnaire modules, please refer to Marshall et al.[10]

Factual questions: Questionnaires often begin with factual questions because they offer a straightforward way to warm up into the questioning process. They are followed by a range of response options, of which respondents may choose one or many, as determined during the question design (and informed by the preliminary study). There is some leeway in reading factual questions – for instance, explanations can be offered to correct any misunderstandings – because they are not sensitive to question wording like opinion or attitude-based questions are.

The first module of the quantitative Mali survey consisted of a number of factual questions covering the topics of disease, heredity and GMOs. This is the first module of the questionnaire, and hence acts as a warm up for the interviewees. Three of these questions are shown in Table 20 (Questions 2, 3A and 3B). The questions and response options are closely based on the results of the preliminary study.[9] In the study, most respondents cited God and sharing the same blood as the main reasons why offspring resemble their parents, while a few educated people made reference to genes, as listed in Question 2. Most respondents were familiar with selective breeding, citing its use in raising more desirable pigs, goats, cereal crops and fruit trees, as listed in Question 3B. Note the inclusion of options for "other (please specify)" and/or "don't know" in each of these questions. This is important to ensure that all response options are covered; but should only be used when necessary. Also note the skip pattern for Question 3A which means that Question 3B ("Which animals, vegetables or fruits are selectively bred in your community?") is only asked if selective breeding is practised in the community.

Table 20. Examples of factual questions

No.	Questions and filters	Coding categories		Skip
2	In nature, it is common for offspring to resemble their parents – for example, a daughter may resemble her mother in some ways, and her father in other ways. What do you consider to be the reason for this resemblance? You may choose more than one option.	BLOOD GOD AFFECTION GENES NONE OF THE ABOVE DON'T KNOW OTHER _____ (SPECIFY)	1 2 3 4 5 88 6	
3A	Does your community take advantage of the resemblance between parents and offspring to selectively raise animals, vegetables or fruits with desired characteristics?	YES NO DON'T KNOW	1 2 88	 --> 4A --> 4A

Table 20. Examples of factual questions (continued)

No.	Questions and filters	Coding categories		Skip
3B	Which animals, vegetables or fruits are selectively bred in your community? You may choose more than one option.	GOATS CHICKEN MANGO TREES COWS PIGS ORANGE TREES CEREAL CROPS HORSES DON'T KNOW OTHER _____ (SPECIFY)	1 2 3 4 5 6 7 8 88 9	

Scale questions: These are sometimes referred to as opinion questions and consist of a series of questions with graded response options. The scale can have several levels of intensity, or simply consist of yes/no/don't know options, in which case they are sometimes collectively referred to as list questions. Responses can be added together, weighted by intensity, and used to obtain a crude "score" for each respondent. Factor analysis can then be used to see whether scores correlate with certain covariates (gender, age, number of children, etc.).

Modules two and three of the quantitative Mali survey contain several scale questions covering the requirements, concerns and trusted organizations for a release of GM crops and GMMs. Two of these questions are shown in Table 21 (Questions 9 and 11). As before, the questions and response options are closely based on the results of the preliminary study.[9] In this study, participants were told to imagine that an organization from a foreign country could provide them a GMM that would be able to reduce the burden of malaria in their community, but could have unknown consequences. A large number of respondents wanted to see the results of a trial before accepting a release in their community, most of whom wanted the trial to be conducted in a community other than their own. A number of other requirements were mentioned, such as evidence from laboratory experiments and the provision of bednets with the release.

In Question 9, respondents are asked to rate these requirements on a scale of one (not important) to three (very important). Combining the responses of several people allows us to scale the relative importance of each requirement to see whether different groups of people tend to have different sets of requirements. In Question 11, respondents are asked whether they would accept a release of GMMs in their community if some of these requirements were satisfied. Affirmative responses to the first six options may be added to obtain a crude "acceptability score" for each respondent. Factor analysis may also be used to see whether certain requirements tend to be grouped together.[24] Note the inclusion of "always" and "never" options in Question 11 for completeness.

Table 21. Examples of scale questions

No.	Questions and filters	Coding categories				Skip
9	Here are some concerns that people in Mali have about GMMs. Please read through the list and, for each concern, indicate how much it worries you.	VERY WORRIED	A LITTLE WORRIED	NOT WORRIED	DON'TKNOW	
	(a) GMMs will continue to transmit malaria	1	2	3	8	
	(b) GMMs will be resistant to insecticides	1	2	3	8	
	(c) GMMs will transmit diseases other than malaria	1	2	3	8	
	(d) Accidentally eating GMMs will make me sick	1	2	3	8	
	(e) GMMs will harm the environment	1	2	3	8	
	(f) GMMs will be expensive for the community	1	2	3	8	
	(g) Other _____ (SPECIFY)	1	2	3	8	
11	Under what circumstances would you consider it acceptable to release GMMs in your community?	YES	NO	DON'T KNOW		
	"I would consider it acceptable to release GM mosquitoes in my community…					
	(a) … if the United Nations said they were safe and help reduce the number of malaria cases."	1	2	8		
	(b) … if the Malian government said they were safe and help reduce the number of malaria cases."	1	2	8		
	(c) … if they were approved by a majority of my community."	1	2	8		
	(d) … if I saw the results of a successful trial in a nearby community."	1	2	8		
	(e) … if I saw the results of a successful laboratory experiment."	1	2	8		
	(f) … if it was possible to abort the project."	1	2	8		
	(g) …always. I approve of releasing GM mosquitoes unconditionally."	1	2	8		
	(h) …never. I don't approve of releasing GM mosquitoes under any circumstances."	1	2	8		

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Attitude statements: Attitude statements are single sentences that express a belief or point of view and are phrased so that respondents can either agree or disagree with varying intensity.[16] For example, "It is the duty of doctors to keep people alive for as long as possible: (a) Strongly agree; (b) Agree; (c) Neutral/undecided; (d) Disagree; (e) Strongly disagree." By using a pool of such statements, it is hoped that people can be placed on an attitudinal scale, in relative terms. Half of this pool should be positive and half should be negative, in order to compensate for the tendency of people to give affirmative responses. Before use, attitude statements should be placed in random order. They must also be read precisely, because responses may vary according to their wording.

A series of six attitude statements about GMMs are listed in Table 22. To generate these, six statements were chosen from the preliminary interview transcripts – three favourable and three unfavourable – about GMMs, which were then randomized and assigned a Likert response scale.[25] Here, favourable statements are scored from five (strongly agree) to one (strongly disagree) and unfavourable statements are scored from one (strongly agree) to five (strongly disagree). Total scores can serve as a crude measure of favourability towards GMMs. This can then be compared between groups of respondents and analysed to see how it relates to other variables.

Table 22. Examples of attitude questions

No.	Questions and filters	Coding categories					Skip
12	For each of the following statements regarding GMMs, please indicate to what extent you agree or disagree.	STRONGLY AGREE	AGREE	DISAGREE	STRONGLY DISAGREE	DON'T KNOW	
	(a) A mosquito is a mosquito – modified or unmodified, it will always transmit malaria.	1	2	3	4	8	
	(b) If the United Nations tells me that GMMs will be good for my community, I will believe them.	1	2	3	4	8	
	(c) Malaria is far worse than any negative consequences that the GMMs could have.	1	2	3	4	8	
	(d) If GMMs could have unknown risks, then they shouldn't be released.	1	2	3	4	8	
	(e) Bednets and insecticides have barely reduced the number of malaria cases in Africa. GMMs will not be any different.	1	2	3	4	8	
	(f) We have tried to kill mosquitoes and it hasn't worked. It is better to modify them so they can't transmit diseases.	1	2	3	4	8	

Demographic questions: These are factual questions selected with secondary hypotheses in mind – for example, do attitudes to GMMs correlate with age group, gender or parenthood? Hypothetically, mothers may support a release to protect their children against malaria, or oppose a release to protect their children from the risks of an unknown technology. These are included at the end of the Mali quantitative survey[10] so that respondents know what they are linking their information to;[16] however they could equally be placed at the beginning of the questionnaire as warm-up questions. A few examples of demographic questions from the Mali quantitative survey are provided in Table 23.

Table 23. Examples of demographic questions

No.	Questions and filters	Coding categories		Skip
D1	How old are you?	18–29 30–39 40–49 50–59 60+ DON'T KNOW	1 2 3 4 5 88	
D2	Are you male or female?	MALE FEMALE	1 2	
D3	Do you have any children?	YES NO	1 2	

Finally, it is worth noting that questionnaire design is highly dependent on the results of preliminary qualitative interviews. For surveys in other DECs, it would be necessary to conduct these studies before design begins; however, the internal logic of the inquiry should be relatively general. A general progression from factual questions on disease, heredity and GMOs, to opinion and attitude questions on GMMs, to demographic questions should remain appropriate.

11.2.4 Step 4: Pilot the questionnaire

Questionnaires do not emerge out of the design phase in their final form – they must be tested, improved and tested again, possibly several times over. This process is referred to as "piloting".[16] Every aspect of the questionnaire should be piloted, from the wording of questions to the relative positions of answer categories in a list, to the interview setting, to the amount of space allocated for a "please specify" option. Expert advice can help to point out aspects of a questionnaire that might be problematic, but this is no substitute for actual pilot work. Respondents in a pilot study should be drawn from the population of interest and should be as diverse as possible, essentially forming a judgment sample.

In the Mali quantitative survey, several aspects should be piloted. The questionnaire is quite long, which suggests that respondent fatigue might be a problem. If it is, then which questions should be left out? Are there particular questions that respondents have trouble with? Is the module on GM crops informative and useful, or would the questionnaire be more efficient without it? Do respondents make regular use of "please specify" options, and if so, should more response options be included? Are response options to some questions redundant? Attention should also be paid to contextual effects relating to the order of the questions, for example, do earlier questions on GMMs affect levels of agreement with

subsequent attitude statements? Other questions relate to the method of questionnaire delivery. Does the gender, ethnicity or nationality of the interviewer affect the responses? Do female respondents feel more comfortable with female interviewers? And should the interviewer read out the questions and response options every time, or should literate respondents be allowed to complete the questionnaire in writing? This consideration is important because spoken interviews are more susceptible to social desirability bias, which could disproportionately influence the responses of illiterate respondents.

Some questions require particular attention. For example, a definition of "genetic engineering" is provided early on in the survey. How do responses to questions on GMMs and GM crops change when the definition of genetic engineering is also changed? The wording of the introductory sections to questions on GM crops and GMMs should also be experimented with. In Question 9, is a three-level rating scale optimal, or should more or less levels be provided? Are show cards helpful for these questions? Finally, the attitude statements in Question 12 (Table 22) must go through several stages of testing and improvement. Unfavourable statements can be spotted if respondents quibble, if there are many "don't know" responses, or if the statements are skipped or crossed out. An item analysis can be used to determine which statements are most informative. This is done by calculating the correlation coefficient of each statement with the total statement pool, and keeping the statements with the highest correlation coefficients. It should be checked whether a training session on Likert scales leads to more informative responses. One possibility is to have respondents fill out a brief survey on how much they like the taste of different foods in order to familiarize them with the use of linear scales.

11.3 Discussion

Public consultation is essential prior to field trials of GMMs; however very little data are available on DEC views of GMMs. This chapter has outlined how to conduct a descriptive survey of attitudes to GMMs in Mali, and described the main steps required to conduct a quantitative survey of this technology in a DEC. These steps include: (i) sampling from the population of interest; (ii) conducting a preliminary qualitative study; (iii) designing the questionnaire; and (iv) piloting the questionnaire to enhance its efficacy. The focus has been on the population replacement strategy for malaria as an example;[14] however, the methodology can easily be adapted to other locations, diseases and transgenic strategies. In Brazil and Malaysia, for instance, a release of genetically sterile males is being considered to suppress the local *Ae. aegypti* population – the main vector of dengue fever and chikungunya.[26,27] For surveys in these locations, the questions on disease causation and GMMs would need to be altered accordingly.

For researchers interested in conducting these surveys, a number of caveats should be kept in mind. First, initial views on GMMs may be obtained before field trials have been conducted. Hypothetical questions are known to have poor predictive reliability,[16] which should be kept in mind when interpreting the results of early surveys. Second, describing GMMs requires several essential words, such as "gene" and "genetic engineering," which are difficult to explain in local dialects. It is therefore important to understand what respondents understand by these terms and the context in which they give their responses. Third, in many DECs, including Mali, there are a number of local dialects into which the questionnaire must be translated. Translation leads to subtle changes in meanings and overtones, which should be acknowledged because attitude statements can be very sensitive to these changes.

Sources of bias should be identified and minimized, particularly for opinion and attitude-based questions. Some of the main types of bias in quantitative surveys are non-response bias, interviewer bias, social desirability bias and question-

naire bias. The number of non-respondents is less of a problem than the possibility that non-respondents hold distinct attitudes. If a chief who disapproves of the survey is less likely to approve of GMMs, and this view is reflected in his community, this could lead to bias. Building a rapport with the community and providing incentives can minimize this bias. Interviewer bias can be caused, for example, when interviewers become careless at some point during their repetitive task. This can be managed by providing encouragement, reducing shift lengths, and following up with quality control. Social desirability bias occurs when questions are loaded with prestige. For example, people like to appear knowledgeable so they may claim to have heard of more GMOs than they really have. One solution is to ask questions in an indirect way so that respondents do not know the purpose behind the question. Another solution, used by Cobb[7] in Key West, Florida, USA, is computer-assisted self-interviewing. Here, respondents are given an iPad or similar device to administer the survey themselves, allowing them to provide responses confidentially. Interviewer assistance is available if required. Finally, questionnaire bias can be minimized through good questionnaire design.

Previous surveys of public attitudes to GMMs

Several surveys have been conducted on public attitudes to GMOs in Western nations;[18–21] however, the first one to include a question on people's views of GMMs was a survey in Japan by Masakazu and Macer,[11] and the first survey in a DEC was the case study described here by Marshall et al.[9] Since then, the technology has progressed very quickly, with releases of sterile GMMs having already taken place in the Cayman Islands, Brazil and Malaysia.[4,26,27] Public attitudes were reportedly studied prior to the releases in Brazil and Malaysia; however these studies have not yet been published.

Other studies are scarce and have been limited to researchers specializing in the technology or to citizens in developed countries. A paper by Boete[28] documents the views of people working on malaria and mosquito control, particularly their attitude to public involvement in the research process. This study suggests that more than 90% of researchers working on GMMs welcome interactions with the public. However, only 52% of these researchers were comfortable with their work being submitted for evaluation and prior agreement by the public. Researchers working on other aspects of malaria and vector control were more comfortable with such an evaluation. Boete argues that, since GMMs are one of the more controversial novel vector control strategies, structures should be set in place that encourage better public involvement in debates about the technology.[28]

In the USA, a nationwide poll on attitudes to GMMs conducted in 2012[29] found mixed support for the technology. Most of the respondents were unaware of the technology, and support varied depending on whether the mosquitoes were labelled as "genetically engineered" or "sterile." Furthermore, support was lower if risks were included in the information provided to respondents. This survey was followed by two more detailed surveys in Key West, Florida, USA,[6,7] which could possibly be the first location in the country to conduct open field trials of GMMs.

Interestingly, both awareness and support for the technology was higher in Florida. In a large-scale mail survey, 61% of respondents supported the use of GMMs to control dengue fever in their community (compared to 18% who opposed it), and GMMs were generally considered a safer technology than chemical insecticides.[6] One source of bias in these results was the increased response rate of older, better-educated and wealthier community members (as compared to census data). Cobb suggested including a cell phone sub-sample and an inducement (e.g. a US$500 prize pool) to increase the response rate among other demographics. These results were mirrored in a complementary in-person survey over the same period.[7] However, Cobb suggests that few respondents had thought very deeply about the issue as evidenced by the lack of benefits and risks provided when respondents were prompted to provide these. Consequently, opinions regarding GMMs among this population could be highly malleable.

CHAPTER 11
Measuring public attitudes to releases of transgenic mosquitoes for disease control

The work on the assessment of public attitudes to GMMs has to be encouraged in all DECs where these strategies are being considered. The disease of interest, strategy of control and local cultural beliefs may all differ; but the underlying methodology will remain the same. In all cases, new preliminary studies will be required and piloting will be necessary, but it is hoped that the case study discussed here will provide a useful template. These studies will provide useful information on the level of public support for novel genetic strategies in combatting dengue fever, chikungunya and malaria.

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