

IMPROVING HATCHERY BIOSECURITY FOR A SUSTAINABLE SHRIMP INDUSTRY IN BANGLADESH

QUARTERLY PROGRESS REPORT
NOVEMBER 2020- JANUARY 2021

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Executive summary

“Improving hatchery biosecurity for a sustainable shrimp industry in Bangladesh” project is funded by Biotechnology and biological sciences research council, UK. University of Exeter, UK, WorldFish and Association of Realization for basic needs (ARBAN) are implementing partners of this project. The objective of the report is to describe quarterly progress of the project activities during November- January, 2020-2021.

The achievements during the quarter include (i) preparation of self-assessment biosecurity app content, (ii) develop monitoring sheets for 1) water quality parameters 2) farm visitor log sample 3) feeding and, 4) animal health, (iii) develop communication questionnaire based on information ecosystem assessment and, (iv) analysis of baseline survey data.

Project objectives, activities and progress (November- January, 2020-2021)

Project objectives	WF Activities	Progress (November – January, 2020-2021)	Remarks
<p>Objective 1. Assessment of the biological, physicochemical and socioeconomic parameters of 15 hatcheries to create bespoke biosecurity management strategies.</p>	<p>Phase 2 activity planning (Preparing self-assessment biosecurity app, creating monitoring sheets, developing communication questionnaire)</p>	<p>WF and UoE team along with national partner (ARBAN) discussed and finalize work plan for phase 2</p>	
	<p>Supporting hatcheries to improve biosecurity</p>	<ul style="list-style-type: none"> • Prepared self-assessment of biosecurity app content (Annex 1) • Development of mock user interface for the biosecurity app content (Annex 2) 	
	<p>Development of monitoring sheets</p>	<ul style="list-style-type: none"> • Develop monitoring sheets for 1) water quality parameters 2) farm visitor log sample 3) feeding and, 4) animal health (Annex 3) • Monitoring sheet field tests have been conducted in some hatcheries and opinions of hatchery consultants have been sought 	
	<p>Communication Questionnaire development and data collection</p>	<ul style="list-style-type: none"> • A communication questionnaire has been developed with support from the UoE and ARBAN team for knowing which communication channel route is the most effective way of communication. (Annex 4) • Communication data has been collected from the key staff of the selected hatcheries through face to face interview using the questionnaire. Interview conducted with either hatchery consultant or hatchery technicians who are mainly involved in hatchery production part. 	

	Baseline survey data analysis	<ul style="list-style-type: none"> Total 13 number of hatcheries were visited and 11 different participants were involved in this survey. Graphical representation of Analysed baseline survey data (Annex 5) 	
Objective 2: Enhanced awareness amongst farmers of BMPs for receiving PL from hatcheries, and optimized practice for PL pond introduction.	<ul style="list-style-type: none"> Facebook group creation Upload biosecurity video 	<ul style="list-style-type: none"> Activities will be performed in next quarter. 	
Objective 3: Collect and disseminate evidence of the benefits of increased biosecurity.	<ul style="list-style-type: none"> Assess the pathogenic, physicochemical and socioeconomic impacts. Compare onward potential of seed from improved biosecurity hatcheries Dissemination of outcomes. 	<ul style="list-style-type: none"> Activities will be performed in 2nd phase. 	

Project activities (communication channel questionnaire, self-assessment biosecurity app content questionnaire) image showed in the photo gallery.











Annexes 1: Self-Assessment Biosecurity App Content

Self-Assessment Biosecurity App Content

Introduction: What is biosecurity and why does it matter?

1. Section 1: Stop pathogens getting into your hatchery

Link to video 2

Question	Green answer (best practice)	Yellow answer (better but not best practice)	Red answer (poor biosecurity practice)	Additional info	Image number
People					
Do you have a secure fenced perimeter or well-defined boundary and restrict entrance to keep out unwanted visitors (humans and animals)?	Yes, it is very difficult for unwanted visitors to access the hatchery site.	We have some fencing but unwanted visitors do enter the site sometimes	It is easy for unwanted visitors to enter the hatchery site.	Humans and animals (pets, wildlife) carry pathogens so they should not be allowed onto the hatchery site without first assessing their biosecurity risk.	Image (1-11)
Do you lock the hatchery during non-visitor hours?	Always	Sometimes	Never		Image (12-17)
Do you keep the number of visitors to a minimum?	Always	Sometimes	Never	The more visitors, the greater the risk that someone will bring in a pathogen.	Image (18-20)
Do you keep a log book of visitors and explain the biosecurity rules to each person?	Yes, we have a log book in reception. The biosecurity rules are read aloud to each visitor and they must sign a sheet to confirm their	We keep some records of visitors.	Visitors can enter the hatchery whenever they need to.	It is important that every person that enters the hatchery practices good biosecurity.	Image (21-24)

	understanding, before being allowed access.				
Do you refuse access to the production area if people have been in contact with other shrimp/hatchery facilities in the previous 72 hours?	Yes, this is made clear in the biosecurity guidelines and people who have visited other shrimp facilities in the previous 72 hours are strictly not allowed access.	Occasionally entry is allowed by maintaining all biosecurity required for work.	No, we do not ask people if they have been in contact with shrimp facilities in the past 72 hours	Other shrimp facilities are the most likely place to contain shrimp pathogens. Shrimp pathogens can live on people's clothes and skin for up to 72 hours, so they need to wait this time before entering your production area.	Image (25-26)
Do you ensure staff and visitors use specific clean clothing and footwear when entering the production area?	Yes, we have a dedicated changing area and clean work clothes that staff need to wear when accessing the production area.	Sometimes people wear specific clean clothes and sometimes they wear home clothes to the production area of the hatchery.	No, they always wear the same clothing as they come to work in.	Regular clothing and footwear will contain microbes that are not present in the hatchery. Some of these may be pathogens. By using hatchery clothing and footwear you will reduce the risk of introducing pathogen.	Image (27-29)
Do you allow sick staff to work?	No. Staff health is checked regularly and anyone who shows signs of illness is not allowed on site.	We have a shortage of staff, so sometimes we allow them to enter even if they are sick	Always	Staff health condition should be checked and recorded regularly.	Image (30-31)
Water					
Do you have	Yes, all three	2 of these	1 or none	It is important to	Image

<p>facilities for water temperature regulation, disinfection and aeration?</p>				<p>maintain these factors throughout the entire larval rearing process for optimal animal health. Disinfection removes any harmful pathogens. Aeration is essential for ensuring sufficient dissolved oxygen for animals to breathe. Maintaining an even water temperature through turbulence will also help reduce the ammonia content in the water.</p>	<p>(32-42)</p>
<p>Does your hatchery have different water supplies for each unit?</p>	<p>Yes, each unit has a separate water supply</p>	<p>Some units have their own water supply</p>	<p>No, the water moves from one unit to the next.</p>	<p>By providing a clean water supply to each unit, you can maximise animal health in each unit and more easily contain any disease outbreaks.</p>	<p>Image (43-59)</p>
<p>How do you disinfect the sea water entering your hatchery?</p>	<p>Step 1: Allow water to settle and use a slow sand filter to remove all organic matter. Step 2:</p>	<p>My hatchery follows steps 1, 2 and 4</p>	<p>My hatchery follows step 1 only</p>	<p>If your hatchery is close to other hatcheries, industries or towns, the water is likely to be polluted with</p>	<p>Image (60-98)</p>

	<p>Chlorination (10 ppm active chlorine) for 12 to 24 hours without aeration, followed by 3 to 4 days with high aeration to remove the chlorine (or if urgent then we use sodium thiosulphate to remove chlorine). Step 3: Water is passed through a series filter. Step 4: Water is passed through first 5 µm and then 1 µm cartridge filters, and finally UV or ozone filters before either entering overhead storage tanks or going direct to the larval rearing tanks.</p>			<p>pathogens. Filters and treatment are designed to get rid of pathogens and chemicals that affect animal health.</p> <p>Please see here for more information on treating incoming sea water.</p>	
<p>Do you check the sea water quality parameters before disinfection?</p>	<p>Yes, before the water is brought into the facility, we check salinity and other water quality parameters, such as pH, temperature, oxygen and levels of heavy metals/pesticides, etc.</p>	<p>We sometimes check these parameters</p>	<p>We do not check these parameters</p>	<p>If you need to balance any parameter, this should be done before the disinfecting process, in case you introduce any pathogens. For example, if the source water doesn't have the preferred salinity, mix salt first to get it correct, and then</p>	<p>Image (99-102)</p>

				go for disinfection.	
How often do you check the efficacy of your disinfection process using simple plate count methods?	Daily	Monthly or less often	Never	This is important to make sure the disinfection methods are effective.	
How often do you test sea water quality parameters (pH, temp, salinity, etc)?	Daily	Weekly	Monthly or less often	These aspects of water quality are important for maintaining optimal animal health and minimal pathogen growth. If animals are healthier they can fight off the pathogens better. For guidance on what standards to use for each parameter, see XXXXX (link). *We will provide the link later – waiting for Solidaridad to release their guidelines*	Image (103-106)
Do you add probiotics after disinfection, for matured water?	Yes	Sometimes	Never	Probiotics can also contain pathogens. It is important to buy probiotics from a reputable supplier.	Image (107)
How often do you keep records of water quality	Daily	Weekly or less often	Never	It is important to keep records of water quality so that you can see	Image (108)

(both pathogen levels and other aspects)?				any changes over time. This is especially useful for understanding the source of disease outbreaks.	
Do you take precautions to remove unwanted biotic (egg/larvae of shrimp and fish species) and abiotic materials (floating waste) from sea water?	Yes – my hatchery uses a protein skimmer to remove these materials before being passed through the slow sand filter.	We remove some materials.	No	This will help to eliminate sources of pathogens or anything that pathogens might feed off.	
How often do you change and/or disinfect sea water filters?	After every cycle or more often, according to the recommendations .	Every 2 cycles	Every 3 or more cycles	Filters become ineffective after time. You should change them regularly to keep them working as effectively as possible. Recommended practice for changing/checking filters: -Ozone = XXXX how often should this be changed/checked? -Sand filter = sand should be washed and disinfected every 6 months	Image (109-116)

				with 200ppm calcium hypochlorite -Protein skimmer = XXX -Gravel filter = XXX -Cartridge filter = XXX -UV filter = UV lamp should be changed after every cycle	
How often do you disinfect your overhead tank and pipes used for sea water transfer?	After every cycle or more often	Every 2 cycles	Every 3 or more cycles	Over time, environments can build up in your tank and pipes that encourage pathogen growth. Cleaning your water tank and pipes regularly helps to avoid this.	Image (117)
How long do you store disinfected sea water in a reservoir or overhead tank?	3 days	24 hours	Less than 24 hours		
How do you filter your fresh water?	Pass water through a slow sand filter then a 1µm bag filter	We use one type of filter only	We do not filter our fresh water		Image (118)
How often do you test the water quality parameters of your fresh water?	Before starting each step	XXX	Test only beginning of each cycle		Image (119)
Broodstock					
Do you check	Yes, newly	Sometimes	Never	Broodstock should be	Image (120-

<p>health status of incoming broodstock and sort them accordingly?</p>	<p>acquired broodstock are sorted or separated upon arrival and are not mixed with existing stocks until their health status is ascertained.</p>			<p>checked for signs of disease, to ensure they are not introducing disease to other broodstock as well as to the facility.</p> <p>Recommended methods of testing health status include: -Eye observations of physical appearance (colour, length, maturation stage) -Microscopic checks to measure microbiological load and contamination -PCR screening for pathogens (e.g. WSSV, AHPND)</p> <p>Further information about health screening can be found XXXXX(link)</p>	<p>122)</p>
<p>Do you quarantine weak or diseased broodstock?</p>	<p>Always</p>	<p>Sometimes</p>	<p>Never</p>	<p>Animals that appear weak or diseased should be kept in an individual quarantine tanks for observation and disease</p>	<p>Image (123)</p>

				diagnosis. If they are diseased, their condition will likely get worse within a short time, so you will know that it is not safe to use them.	
How do you disinfect broodstock at the point of entry into hatchery?	Yes, we disinfect with 200 ppm iodine for 1 min in closed bags and then float these bags in the tanks for 30 min. We then open the bags, aerate and slowly fill the bags with water from the tank for 30 min before releasing the shrimp into the tank.	We have standard operating procedures for broodstock disinfection but do not follow this every time.	We do not have standard operating procedures for shrimp broodstock and do not disinfect on entry.		
How do you check the pathogen status of your broodstock?	My hatchery has dedicated laboratory facilities that include PCR analysis.	We have basic laboratory facilities (e.g. a microscope, use of agar plates, etc) and use these to carry out routine pathogen inspections.	My hatchery does not check the pathogen status of broodstock and does not have access to such facilities.	Dedicated laboratory facilities ensure that results are accurate, with less chance for cross-contamination.	Image (124)
Do you wash eggs and nauplii?	Always	Sometimes	Never		
What do you do to safely	Incineration	Treatment with bleach	No treatment	Diseased broodstock will be highly	

dispose of diseased broodstock?				contaminated with pathogens	
How do you eliminate all pathogens from the diseased broodstock?	Thoroughly clean and disinfect <u>all possible</u> equipment that the diseased broodstock has come into contact with.	Clean and disinfect the main equipment that the diseased broodstock has come into contact with.	We do not take any additional measures for cleaning after diseased broodstock have entered our facility.	Diseased broodstock are a major source of pathogens into hatcheries.	
Feed					
Where do you source your algae?	From a reputable source or laboratory.	We maintain our own stock and check for purity (HOW CHECK AND HOW OFTEN?)	From a local source, or use old stock.	Algae may easily become contaminated with pathogens so it is important to buy your stock from a reputable source or laboratory. Any pathogens inside the stock will also grow in your algal tank.	
Where do you source your artemia?	Always from a reputable source or laboratory.	Sometimes from a reputable source	From a local source	Reputable brands are more likely to have a high hatching percentage.	
How do you check the microbial status of artemia and algae before adding to the larval tank?	We have on-site laboratory facilities to ensure that the feed is pathogen free before adding it to the larval tank.	We occasionally check the pathogen-free status before adding Artemia nauplii or algae to the larval tanks	My hatchery does not check the microbial status of live feed before adding to larval tanks.	Hatched artemia nauplii are a potential source of pathogen contamination, so standard hatching procedures should be followed. This will optimize cost-efficiency	Image (125-126)

				<p>of use and minimise the risk of contaminating the shrimp larvae.</p> <p>Further information on standard operating procedures can be found XXXX (link)</p>	
How do you ensure that your artificial feed is of a high quality?	My hatchery only uses top quality feed brands	We mix top quality brand feed with other types of feed	We use cheaper alternatives to artificial feed, to make it more cost effective	Please add information about why artificial feed is recommended above alternatives	
How do you disinfect other animal feeds such as cow liver, squid and polychaetes	My hatchery does not use other animal feeds.	When my hatchery uses other animal feeds, we first disinfect with XXX before adding to the broodstock tanks	My hatchery does not disinfect other animal feeds.	Other animal feeds are sources of pathogens. Their use should be minimised, or if you have no alternative then they should be disinfected properly before use.	
Vehicles					
What is your protocol with regards to allowing delivery vehicles access to your hatchery?	Delivery vehicles have wheels disinfected before entrance to the hatchery, and we have designated delivery/loading areas which are regularly cleaned.	Delivery vehicles are sometimes disinfected before allowing access.	Delivery vehicles enter my hatchery whenever they need to and are not disinfected before entrance.	Delivery vehicles will have been to other hatcheries where pathogens may be present. They should only come on-site when absolutely	Image (127)

				necessary.	
What is your protocol with regards to allowing transport vehicles access to your hatchery?	They are not allowed on the premises. After each journey they are cleaned and left to dry for at least 24 hours.	Transport vehicles are allowed on the premises but disinfected before allowing access.	Transport vehicles enter my hatchery whenever they need to and are not disinfected before entrance.	The hatchery's transport vehicles should park outside and not enter the facility at all, since they will be visiting markets or farms where pathogens may be present.	
Are staff vehicles allowed in your hatchery premises?	Never	Sometimes	Whenever they need to.		
Equipment					
Do you assess the biosecurity risk of hatchery equipment before it enters the hatchery?	Always	Sometimes	Never	External equipment may have been contaminated so should be disinfected before entrance to the hatchery.	Image (128-130)
Do you disinfect all equipment entering the hatchery?	Always	Sometimes	Never		Image (131-133)
Does your hatchery have clear protocols for assessing and treating incoming equipment?	Yes, all my staff are familiar with these protocols.	We have some protocols, but not everyone is aware of them.	My hatchery does not have protocols for the assessment and disinfection of incoming equipment.		Image (134-136)
Nature					

Do you have good security to prevent pets or other wildlife entering the hatchery?	Yes – we have a secure fenced perimeter to prevent land animals entering and we use a filter bag for water intake to prevent the entry of any aquatic organism from source water.	We don't allow pets but sometimes land/aquatic wildlife enter the hatchery.	Pets and wildlife can easily get access to the hatchery.	Pets and wildlife can carry pathogens.	Image (137-141)
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Section 2: Stop pathogens growing in your hatchery

Link to video 3

Question	Green answer	Yellow answer	Red answer	Additional info	Image number
Don't give pathogens somewhere to live					
How often do you remove excess food from tanks?	Daily (or after every feed?)	Less than once per day	My hatchery does not remove excess feed	Excess food increases the cost of production unnecessarily, and encourages the growth of pathogens.	
How often do you check that feed is within the expiry date?	Monthly	Less than monthly	My hatchery does not check expiry dates.	After the expiry date the feed is more likely to contain high levels of pathogens and be unsafe to use.	
Does your hatchery have clear protocols for the storage of artificial feed?	Yes, all my staff are familiar with these protocols. We store feed in a cool, clean, dry place and minimise spillages. Feed cans/bags are never brought	We follow some of these best practices.	My hatchery does not have protocols for the storage of artificial feed.	Feed should be stored properly in a cool, clean, dry place. Damp, warm environments encourage the growth of pathogens. Spillages should	

	into production areas.			be minimised to prevent pests coming into your hatchery. Pests carry pathogens. Feed cans/bags should not be brought into production areas.	
How do you store your algae stock?	We collect from a reputable source or laboratory each season.	We maintain our own algae stock without contamination and replace every 2-3 seasons	Algae stock is maintained in the hatchery for many years and replaced every 4 years or less	It is important to store your algae stock properly to prevent bacteria growing in it.	
How often do you start a new stock of algae?	After completion of each cycle.	After completion of each production season	Every two to three years	It is important to use a clean stock algal culture after each cycle.	
How do you disinfect artemia before putting into larval tank?	My hatchery follows standard <i>Artemia</i> hatching procedures which include disinfection, and we regularly check for microbial contamination	We follow standard procedures for hatching but do not check for microbial contamination	My hatchery does not disinfect artemia before adding to larval tank.	Standard artemia hatching procedures include maintaining temperature at XXX, salinity at XXX, ensuring good water quality. For cleaning/disinfection, artemia should be washed in XXX and disinfected by using XXX for XXX minutes.	Image (142-146)
How do you	We follow the	We	My	It is important	

disinfect water used for algae and artemia culture?	same water treatment protocols as for the water supplying the other areas of the hatchery.	occasionally disinfect the water for the algae/artemia tanks.	hatchery does not disinfect algal/artemia tank water.	that there are no pathogens introduced into these tanks as they will multiply in these tanks. These pathogens are likely to stay with the algae/ <i>Artemia</i> when these are added to your larval tanks, and may then cause disease.	
Do you maintain a specific temperature in algal and artemia tanks?	Always	Sometimes	The temperature of these tanks is dependent upon the natural temperature fluctuations, with daily and seasonal changes	Increased temperature makes it more likely that pathogens will grow. 18-24°C is the optimum temperature for allowing algal/artemia growth but limiting pathogen growth.	Image (147-167)
How often do you clean algal and artemia tanks?	Each time after use	Every week	After production cycle		Image (168-177)
How do you disinfect artemia eggs?	Decapsulation and washing with bleach, following the guidelines of the supplier	Wash with bleach	My hatchery does not disinfect Artemia cysts		
How often do you clean surfaces in your hatchery?	Daily	Once in a week	After each production cycle or at the end of the season		Image (178-182)
How often do	Daily	Once in a	Monthly	It is important	Image

<p>you carry out maintenance of equipment?</p>		<p>week</p>		<p>that equipment is well-maintained, to ensure that it is as effective as possible. Poor functioning equipment will reduce environmental conditions and may lead to greater growth of pathogens.</p>	<p>(183-186)</p>
<p>How often do you disinfect all equipment (tanks, air hose pipe, air stone, pipefittings, catch net, etc)?</p>	<p>After each cycle and following a disease occurrence</p>	<p>At the end of each production season, and following a disease occurrence</p>	<p>At the end of each production season</p>	<p>Pathogens can grow on equipment and inside tanks, tubing and pipes. Cleaning and disinfecting these items kills the pathogens that are growing, to keep their number to a minimum. The more pathogens that are present on equipment and tanks, the greater the risk that they will cause disease or spread to other areas of the hatchery, so it is important to clean and disinfect equipment and tanks regularly.</p>	<p>Image (187-215)</p>
<p>How often do you disinfect other equipment (bucket, bowl,</p>	<p>Daily</p>	<p>Weekly</p>	<p>Less often than weekly</p>		<p>Image (216-224)</p>

scope net, beaker, pipe for water exchange,) daily?					
Do you treat diseased animals and infected water before disposal?	Always	Occasionally	Never	<p>Pathogens grow very quickly in sick/diseased animals. Remove and safely dispose of sick/dead animals as quickly as possible. The best way to safely dispose of diseased broodstock is incineration.</p> <p>Diseased tanks and animals should be first treated within their own tanks with 50 ppm hypochlorite solution for at least 1 hour. Dead animals should then be removed and incinerated. The treated water should be well aerated to remove chlorine before discharging into the drainage system.</p>	
How long do you hold discharge water?	Only as long as necessary for effective disinfection and aeration, then	XXX	XXX	Discharge water should not be held for long periods. It contains animal	

	released immediately.			and feed waste, and is a good place for pathogens to grow.	
Keep your animals healthy to fight off pathogens					
How often do you monitor feeding to ensure that animals are healthy and not being overfed?	Daily	Less often	My hatchery does not monitor overfeeding	Don't overfeed your animals – feed little and often, and remove excess food. Monitoring feeding is important to ensure that animals are growing properly, and to ensure you are not using too much. Animals feed less when they are sick, so a reduction in feeding is also a sign of disease.	
Do you keep a log book of feeding?	Always	Sometimes	Never	Keeping records is important to better understand how much feed healthy animals consume. This makes it easier for you to identify health problems early.	
Do you have a clear protocol for animal health monitoring at all	Yes, our protocol makes it clear what to check, how	My hatchery has basic guidelines	My hatchery does not have a	If animal health is closely monitored, disease can be	

life stages?	often, and how to identify symptoms of the main pathogens.	on how to monitor health.	health monitoring protocol.	identified and treated at an early stage, which gives animals a better chance of survival. When a disease is in the late stages there are many more pathogens present and so there is a much greater chance of spreading pathogens to other animals.	
Do all of your staff understand how to identify signs of good health or disease, and do they all understand the hatchery's health monitoring protocol?	Yes, everyone receives regular training at least every X months.	Some of my staff know about this.	Only a small number (less than 5?) of staff know how to monitor animal health.	If all staff are trained in health monitoring then early signs of disease are more likely to be identified.	
How often do you monitor animal health status and pathogen levels?	Daily	Less than once per day	Weekly or less	Monitoring health status and pathogen levels is important to allow you to address any problems before the health deteriorates or the pathogen levels get too high.	
Do you keep records of animal health status monitoring?	Always	Sometimes	Never	Keeping records is important to monitor any deterioration in health status, so	

				<p>that you can treat animals before they get too sick.</p> <p>A template animal health status monitoring sheet can be found here (link).</p>	
How often do you check animal tank environmental conditions (water temperature, pH, ammonia, salinity)?	Twice per day	Every 1-2 days	Less than every 2 days	Animals become stressed when the environment is not correct for them; when they are stressed their bodies are not so good at fighting off pathogens.	Image (225-227)
Do you get a disease diagnosis before treating tanks with antibiotics?	Yes – I do not use antibiotics unless I have been told (by whom?) that they will be effective for the pathogen causing the disease in my hatchery.	I only use antibiotics to treat a disease outbreak, and I do not use them to treat viral infections (e.g. White Spot Disease, XXX).	I regularly use antibiotics to prevent disease in my hatchery.	Do not use antibiotics unless you know that they are the correct treatment for that disease. Antibiotics are effective at killing bacterial pathogens, but they also kill many of the good bacteria that help to keep the animals healthy. Some pathogens (e.g. viruses, such as white spot syndrome virus) cannot be treated with antibiotics, so by treating this disease with antibiotics you	

				will be killing off the good bacteria but not the pathogens. This gives the pathogens more opportunity to take over and make the animals sicker.	
When antibiotics are required, how do you ensure correct dosing?	I read the label or ask an Upazila Fisheries Officer (is this correct?) for advice.	I ask the person who supplied them to give me advice.	I guess, based upon my own experience or ask my neighbour/friend.	Improper dosing can lead to the creation of antibiotic resistant microbes, where antibiotics are no longer effective at treating disease.	
If you use health products (for example immunostimulants, vitamins, minerals, probiotics, prebiotics), how do you ensure that they are likely to be effective?	I purchase them from a reputable supplier and follow the application instructions on the label.	I don't look at the label before applying.	I don't use health products.	Health products are useful for disease control and prevention of the animals, but must be good quality and applied properly to be effective.	

Section 3: Stop pathogens spreading around your hatchery

Link to video 4

Does your hatchery have different sections or units for each life stage (for example maturation, spawning, larval rearing, nursery rearing, algae culture, artemia	Yes, each life stage has its own section or unit.	Some of the life stages have their own section or unit.	My hatchery has all the life stages together without any biosecurity barriers between them.	Separating the different life stages is useful to prevent movement of pathogens. It is easier to manage biosecurity in a hatchery that is separated into	Image (228-261)
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hatching)?				separate sections or units, as if there is a disease outbreak in one unit it can be more easily controlled to prevent the disease spreading to the other units.	
Does your hatchery practice one-directional flow of people, equipment and animals?	Yes, my hatchery has a clear one-way system throughout the production area for people, animals and equipment.	My hatchery has limited movement between some areas.	No, people, equipment and animals can move in any direction they need to.	A one-directional flow of movement will help to minimise pathogens spreading to all areas of the hatchery. Good biosecurity practice is to only allow people, animals and equipment to move in one direction between stages, e.g. through creating a clear one-way system for movement.	
What size are your rearing tanks?	Small size: 4-6 tonnes each	Medium size: 7- 10 tonnes each	Large size: over 10 tonnes each	Smaller tanks are easier to manage, and if pathogens get into one tank you can control and treat any disease without other animals getting	Image (262-265)

				diseased, so it is better to have more, smaller tanks than one big tank.	
Do you allocate hatchery staff specific areas to work in (e.g. staff involved with broodstock do not work in LRT)?	Yes, staff are allocated to a specific unit and any movement is kept to a minimum.	Staff often move between units but take care to carefully disinfect hands and feet, and always visit clean units first.	No, staff move freely from one production unit to another.	This will avoid unnecessary cross contamination of pathogens. If staff need to move between units, they should go to the clean ones first.	Image (266)
Does your hatchery have hand sanitization and footbaths at the entrance to each unit?	Yes, every unit has this.	Some units have this.	No units have this.	This will kill pathogens on shoes and hands to help prevent people from contaminating the unit they are entering. Shallow buckets or trays filled with 200 ppm povidone iodine solution or 50–100 ppm chlorine solution can be used to disinfect the footwear of each person entering the facility. These should be emptied and refilled every day (?).	Image (267-271)
Does your hatchery have	Yes, every unit has this.	Some units have this.	No units have this.	This will kill pathogens on	Image (272)

hand sanitization and footbaths at the exit from each unit?				shoes and hands, helping to prevent the spread of pathogens to other units.	
Does your hatchery keep records of shrimp movements (animals coming into the hatchery and moving within the hatchery)?	Yes, we use animal movement logs to keep records of all broodstock entering the hatchery and movements of larval/PL animals	We keep some records of animal movement.	We do not keep any records of animal movements.	This will help you to better trace the source of any disease, so that you can control it more quickly. Animal movement log sheet templates can be found XXXX (WF website?)	
Does your hatchery minimise movement of animals within your hatchery?	Yes, animals are only moved when xxxxxxxx, and in as few batches as possible.	XXX	Animals are frequently moved around the hatchery.	The movement of animals can increase the spread of pathogens, as each animal has microbes on it (good and bad microbes) but some microbes that do not affect one life stage can cause disease in other life stages.	
Do you have a clear protocol for isolating and reintroducing diseased animals?	Yes, our protocol makes it clear that animals should be isolated when diseased and not reintroduced until it is safe to do so (e.g.	My hatchery isolates diseased animals occasionally, when severe mortality occurs	My hatchery does not isolate diseased animals.	Having clear guidelines on isolating and reintroducing diseased animals makes it easier for staff to follow best practice.	

	animals have recovered and equipment thoroughly cleaned and disinfected).				
Do you have dedicated equipment for each unit?	Yes	Sometimes	No	It is good practice to have separate equipment (e.g. pumps, blowers, pipes) for each unit, to prevent the spread of pathogens between units. These could be colour-coded (one colour per unit) to make it clearer where they should be kept.	
Do you disinfect equipment before transfer to other units?	Always	Sometimes	Never	This will help to prevent movement of pathogens between units.	Image (273-274)

Section 4: Keep disease outbreaks under control

Link to video 5

Question	Green answer	Yellow answer	Red answer	Additional info	Image number
Does your hatchery have standard operating procedures for what to do to prevent, control and manage disease outbreaks?	Yes, My hatchery has Standard Operating Procedures (SOPs) for disease outbreaks, which we follow strictly.	XXX	No, We have no Standard Operating Procedures for disease outbreaks.	It is best practice to make the SOP available to all staff, either by giving them a copy or displaying it in a communal area, e.g. dining room, meeting room.	

How often do you provide training on managing disease outbreaks?	At least every 6 months	Less frequently than every 6 months	I do not provide training		
Do you have a simple and fair system for reporting biosecurity lapses or disease outbreaks?	Yes, (give details of best practice), and all my staff are aware of this.	XXX	My hatchery does not have a plan in place for this.	It is important that staff are clear about who they should report outbreaks to. Short and efficient report chains are best. Staff should be rewarded for practising good biosecurity and for reporting lapses or problems, rather than blaming them.	
Do you have a clear plan for how staff should contain disease outbreaks?	Yes, (give details of best practice), and all my staff are aware of this.	XXX	My hatchery does not have a plan in place for this.		
Are your staff familiar with how to take samples from diseased animals for testing?	Yes, all of our staff are trained on how to collect samples from diseased animals.	XXX	No, my hatchery staff are not trained in sampling diseased animals		
Does your hatchery test samples to identify the pathogen causing the disease outbreak?	Yes, we use in-house or external facilities to quickly identify pathogens.	XXX	No, we do not have access to lab facilities .	Identifying the pathogen is important, as then you can use the most effective treatment plan.	
Does your	Yes, (give best	XXX	No, we do		

hatchery have a clear protocol for decontamination after disease outbreaks?	practice, e.g. list what needs to be decontaminated - facilities/water/equipment - and how), and all my staff are aware of this.		not have a decontamination protocol.		
During a disease outbreak, do you make effort to try to identify the source of the pathogen?	Always	Sometimes	Never	Identifying the source of the pathogen is important, as this shows where your biosecurity may need strengthening. Keeping records of all visitors, incoming animals, equipment, deliveries, water quality, animal health, etc, is all important for helping to identify the source of the pathogen.	

Section 5: Look after your local environment

Link to video 6

Question	Green answer	Yellow answer	Red answer	Additional info	Image number
Do you assess all waste (water and animals) before disposal?	Yes, always	Sometimes	Never	All waste should be assessed to identify biosecurity risks to neighbours.	
Do you treat	Yes, my	We	We never	Hatchery	

<p>waste water before discharge?</p>	<p>discharge water is held temporarily, treated with hypochlorite solution and aerated before being released.</p>	<p>occasionally treat waste water, in tanks which have had diseased animals.</p>	<p>treat our discharge water.</p>	<p>outflow water contains animal waste products that may contain pathogens so could infect your neighbours' hatcheries. Treating discharge water prevents pathogens from your facility getting into the local environment.</p> <p>All water discharged from the hatchery, particularly that known or suspected to be contaminated (for example, water originating from the quarantine areas) should be held temporarily in special concrete or lined sedimentation tanks. From there it should overflow into treatment tanks where the water should be treated with</p>	
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				hypochlorite solution (20 ppm active chlorine for at least 60 min or 50 ppm for at least 30 min). It should then be well aerated to remove the chlorine (which is not healthy for the local environment) before being released.	
Do you remove animal or food waste from the site as quickly as possible?	Remove daily	Remove every 2-7 days	Remove less than once per week	Animal or food waste can attract pests which can bring disease into the area.	
Do you have measures in place to prevent animals escaping into the local environment?	Yes, we have concrete walls around our hatchery and nets over waste water outlets, so there is no way for animals to escape into the local environment.	Occasionally animals escape into the local environment.	We do not have any measures in place, animals frequently escape.	Animals should be prevented from escaping into the natural environment, as they may have pathogens that cause disease in wild animals.	Image (275-276)
Do you minimise the use of chemicals and medicines?	Yes, we only use chemicals and medicines that we know are effective and we only use them when necessary, according to the manufacturers' instructions.	We use many chemicals and medicines, but always follow the manufacturers' instructions.	We use many chemicals and medicines and apply them according to our own knowledge.	Use chemicals and medicines wisely. Chemicals and medicines are important for keeping hatcheries clean and healthy, but they should be used according to the manufacturers'	

				<p>instructions, as they can be poisonous to wild animals and plants in the environment. They can also be poisonous to people, so we must keep their usage to a minimum. Make sure that you have the correct medicines to treat the disease. Remember that antibiotics do not kill all pathogens and also kill the good microbes that keep your animals healthy, so only use antibiotics when you know that they are necessary.</p>	
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Section 6: Monitor and manage your hatchery risks

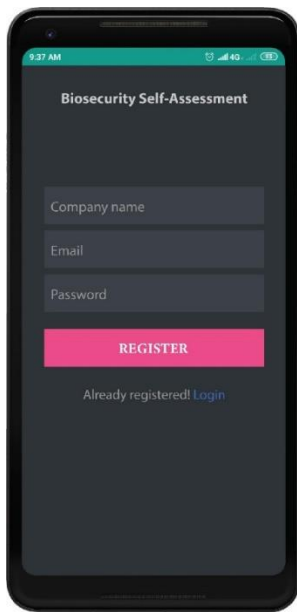
Link to video 7

Question	Green answer	Yellow answer	Red answer	Additional info	Image number
Do you have one (or more) staff member who is responsible for monitoring biosecurity practices in your hatchery?	Yes	N/A	No		

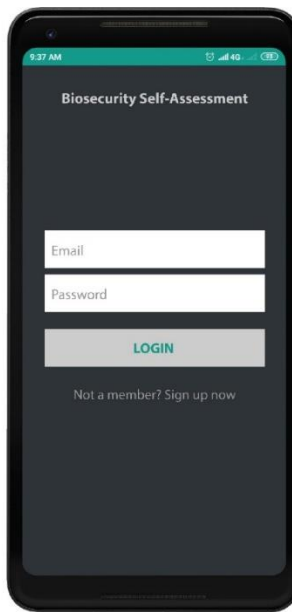
Do you keep written biosecurity protocol documents and share this with your staff members on a regular basis?	Yes – we have written biosecurity guidelines that we share with staff regularly	We have written guidelines but we do not regularly share these with staff	We do not have written guidelines		
Do you think all of your hatchery staff understand what biosecurity means and why it is important for their work?	Yes	N/A	No		
Do you think all of your hatchery staff understand biosecurity protocols and what to do during disease outbreaks?	Yes, all of my hatchery staff are very much aware of the biosecurity protocols	N/A	No, not everyone knows about the protocols		
How often do you organise internal training on biosecurity and hatchery management for all of your hatchery staff?	Once/year or more	Less than once/year	Never		
Does your hatchery provide biosecurity training and access to guidelines for all newly recruited staff?	Yes	Occasionally	Never		
How often do you run a biosecurity audit of your hatchery?	Every 6 months or more often	Less than every 6 months	Never	It is important that any required actions identified through these audits are dealt with as quickly as possible.	

Do you allow workers enough time to do their jobs and try to generate a culture of pride in the hatchery?	Always	Occasionally	Never	Most biosecurity lapses happen when people are rushed, when staff turnover is very high, and/or when those involved don't see the consequences	
Do you keep records of PL sold from your hatchery?	Always	Occasionally	Never		
Do you ask farmers for feedback on the quality of your PL?	Always	Occasionally	Never	This will give you confidence that your biosecurity practice is good, and will build your reputation as a hatchery that cares about PL quality.	
Do you report major disease events to the national CA?	Yes, my hatchery shares disease diagnostic reports.....(how often, who with, etc)	XXX	XXX	*We need to define what the CA is, what is meant by a "major" disease event, and how they would report a disease*	

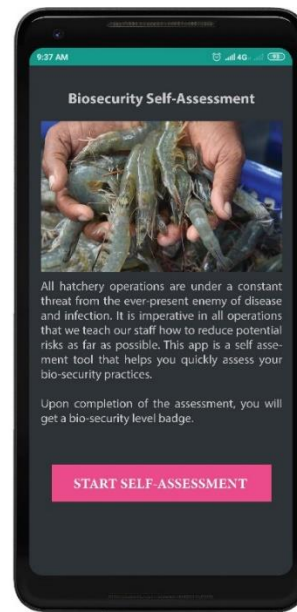
Annexes 2: Mock user interface for app content for self-assessment on hatchery biosecurity



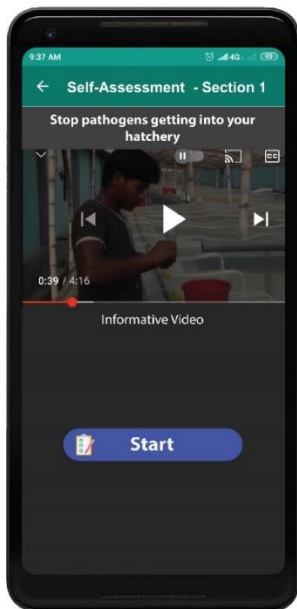
Registration



Login



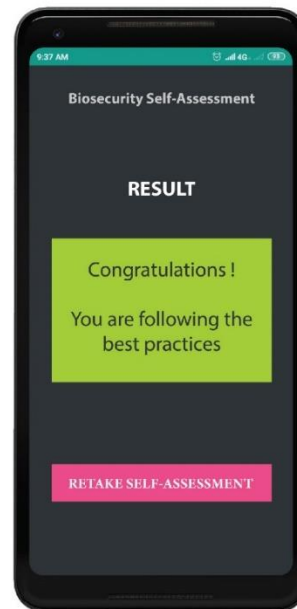
Home



Video



Questions



Result

Management of water reservoirs:

Date:

Reservoir	1	2	Signature
Present volume			
Salinity (ppt)			
Quantity			

Filters maintenance and cleaning:

Date:

Sand filters	Filter 1	Filter 2	Signature
Backwash start time			
Backwash finish time			
Sand exchange (date)			

Cartridges filters	1	2	3	4	Signature
Cleaning time					
Date of new cartridges					

UV filter	1	Signature
Cleaning time		
Date of new lamp		

3.4 Monitoring sheets for larval assessment:

Criteria	Score	Stage	Observation
Swimming activity		All stages	Daily observation
Active (>95%)			
Intermediate (70-95%)			
Weak (on bottom)			
Phototropism		Zoea	Daily observation
Positive			
Intermediate			
Negative			
Fecal string		Zoea	Daily observation
Present			
Intermediate			
Absent			
Luminescence		Mysis	Night observation of the tank
Absence			
Present			
Abundant			
Homogenous stage		All stages	Daily observation
High			
Intermediate			
Low			
Intestinal Contents		Mysis	Daily observation
Full			
Half full			

Annexes 4: Communication channel routes questionnaire

Communication Questionnaire:

- I. Creating a survey questionnaire of communication routes based on information ecosystem assessment.

Communication Channel Routes

1. Respondent Name

2. Designation

3. Name of the Hatchery

4. Do you use a smart phone?

- Yes
 No

5. Do you have internet on your phone?

- Yes
 No

6. Which social media do you use?

7. Where do you get information about the biosecurity of shrimp hatcheries?

- Internet
 Orally
 Read books
 Instructor

8. Which medium do you trust the most?

- Television
 Newspaper
 Radio
 Facebook
 Others

Hatchery communications questionnaire data:

Date of interview	Designation	Do you use a smartphone?	Do you have the internet on your phone?	Which social media do you use?	Where do you get information about the biosecurity of shrimp hatcheries?	Which medium do you trust the most?
11-18-2020	Hatchery Manager	Yes	Yes	Facebook	Instructor	Television
11-18-2020	Accountant	Yes	Yes	Facebook	Internet	Facebook
11-22-2020	Deputy General Manager	Yes	Yes	Facebook	Read books	Newspaper
11-23-2020	Technician	Yes	Yes	Facebook	Internet	Facebook
11-23-2020	Consultant	Yes	Yes	Facebook	Orally	Newspaper
11-29-2020	Technician	Yes	Yes	Facebook	Orally	Facebook

Annexes 5: Baseline survey data analysis

Biosecurity baseline survey August 2020

13 hatcheries visited; 11 different participants

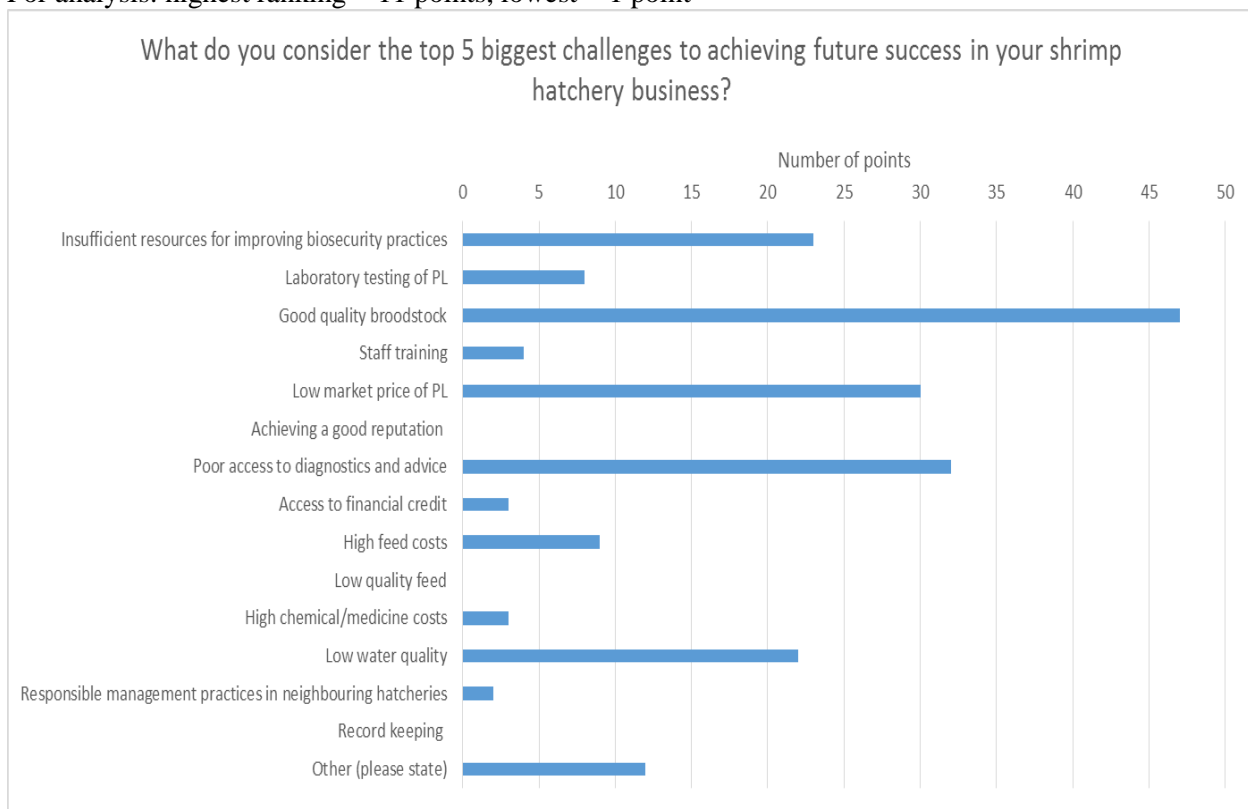
Participant/hatchery information. Red and blue show same participant, providing information for different hatcheries. Participants working with more than one hatchery were asked whether practices differ between them. 3 answered: one said they were the same, one said almost the same and one said they were different due to differences between facilities.

Hatchery number	Designation	Number of hatcheries managed	Production total last year (million)	Production capacity (million)	Operating capacity last year (%)	Years of experience in hatchery sector?
1	Managing Partner	1	400	500	80	22
2	Managing	4	400	500	80	22
3	Consultant	3	350	500	70	30
4	Consultant	3	250	300	83	30
5	Technician	1	300	325	92	20
6	Deputy General	1	420	1000	42	14
7	Managing Partner	1	200	325	62	23
8	Managing director	1	650	1100	59	10
9	Technician	1	470	600	78	5
10	Consultant	2	100	400	25	19
11	Consultant	2	450	500	90	30
12	Consultant	2	460	500	92	30
13	Chairman	1	400	550	73	20

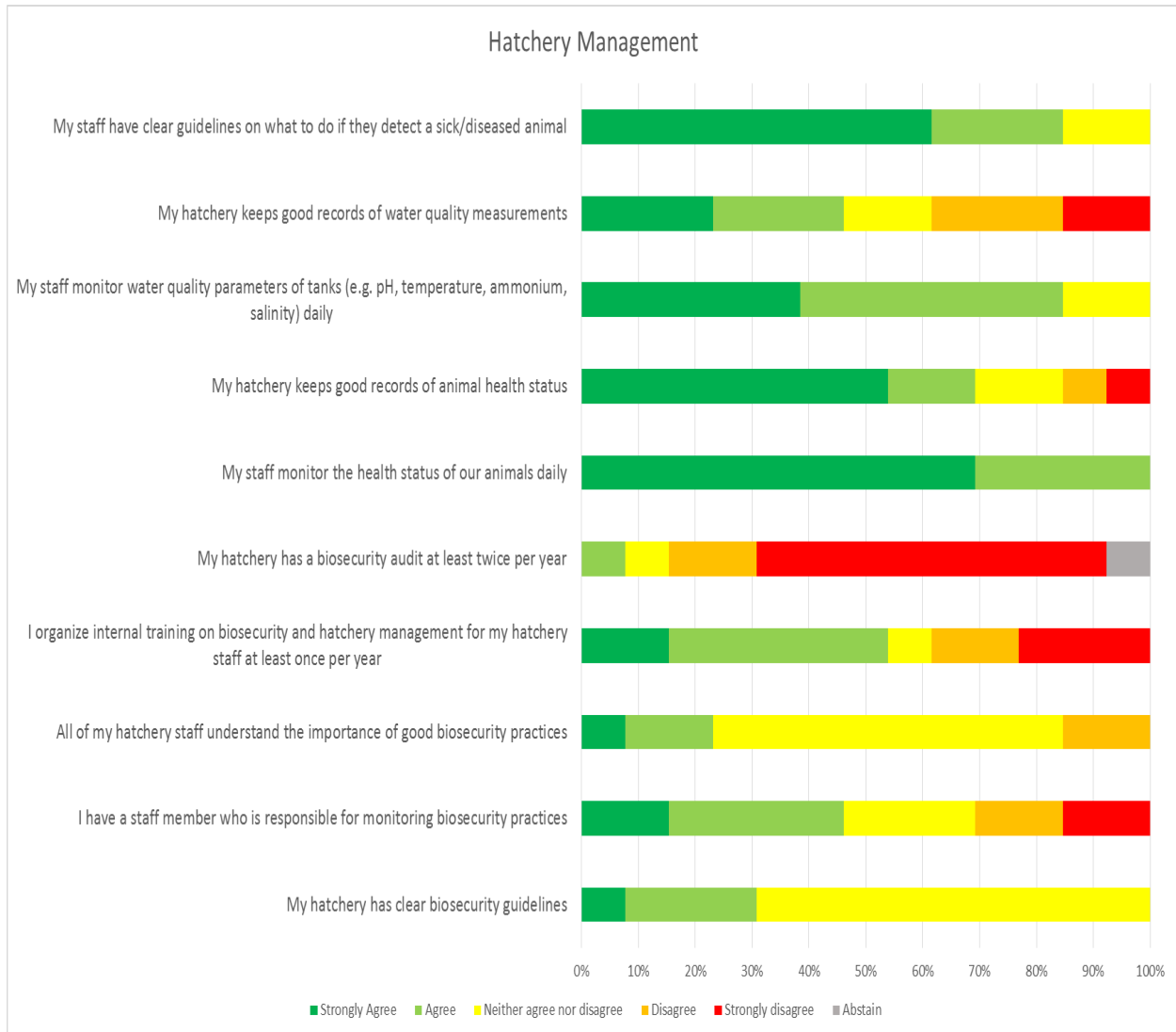
The following data is shown for all 13 hatcheries (i.e. two of the participants were answering twice)

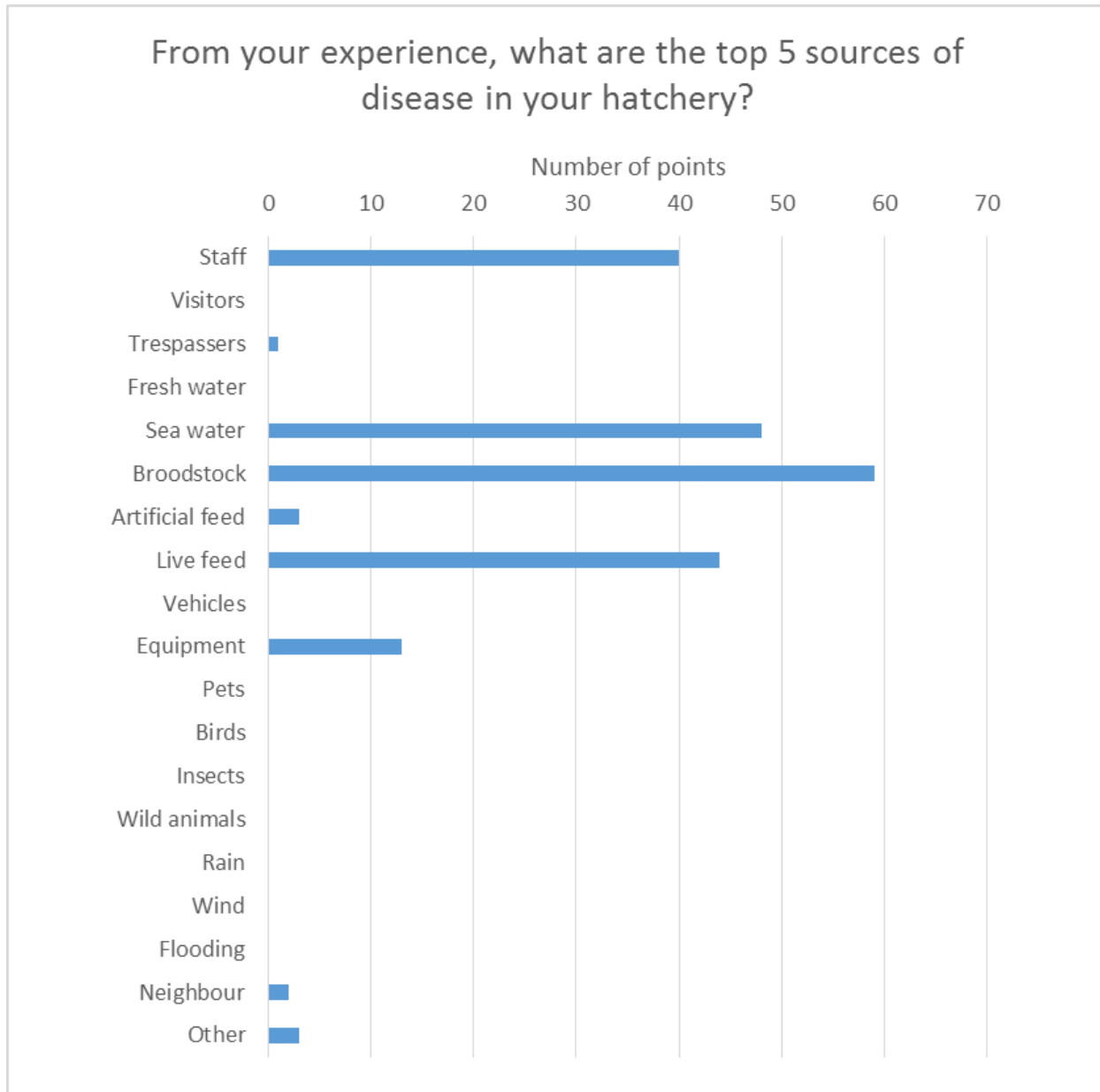


Participants were given these 11 options.
For analysis: highest ranking = 11 points, lowest = 1 point

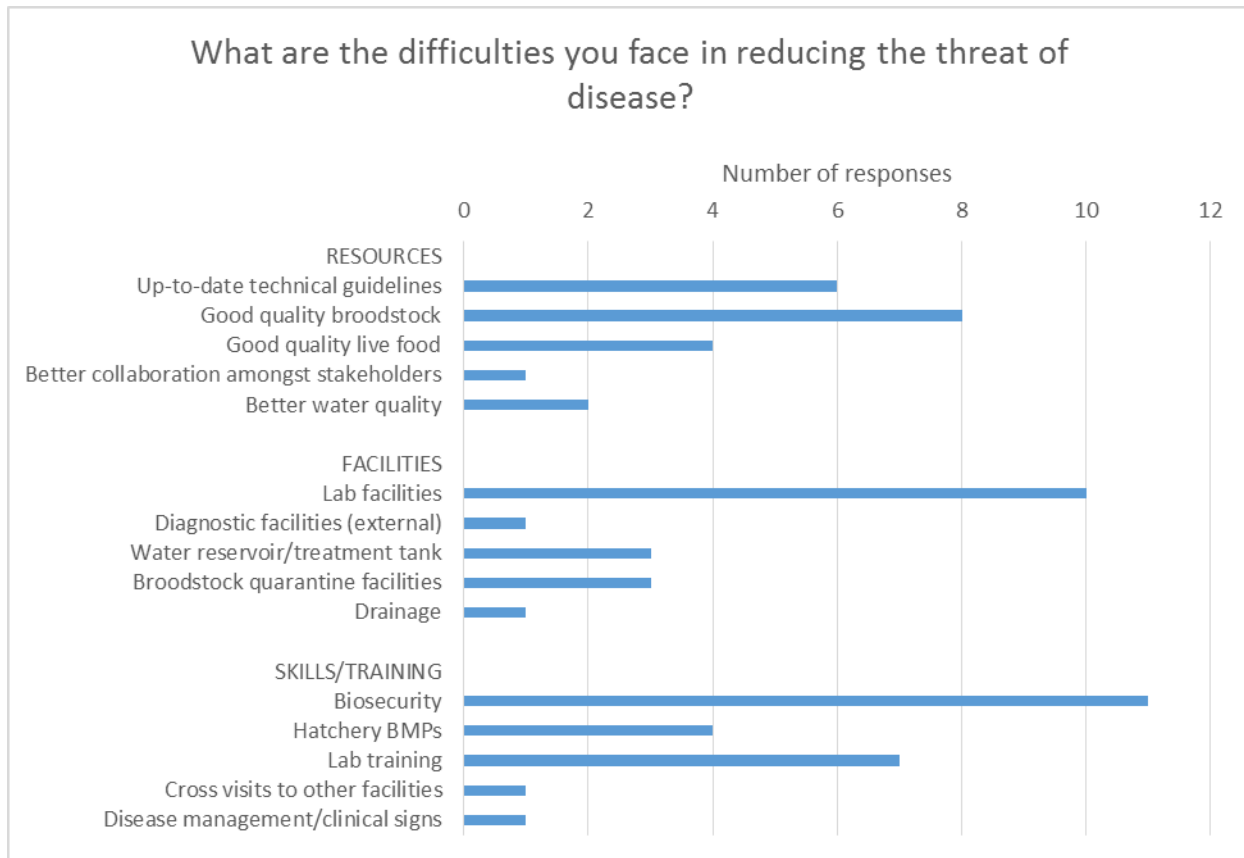


Participants were given these 14 options. For analysis: highest ranking = 5 points, lowest = 1 point. Total points shown. Others (3) = PL transportation (1), unknown amount of PL produced (1), lack of farmer awareness on benefits of stocking good quality PL (1).



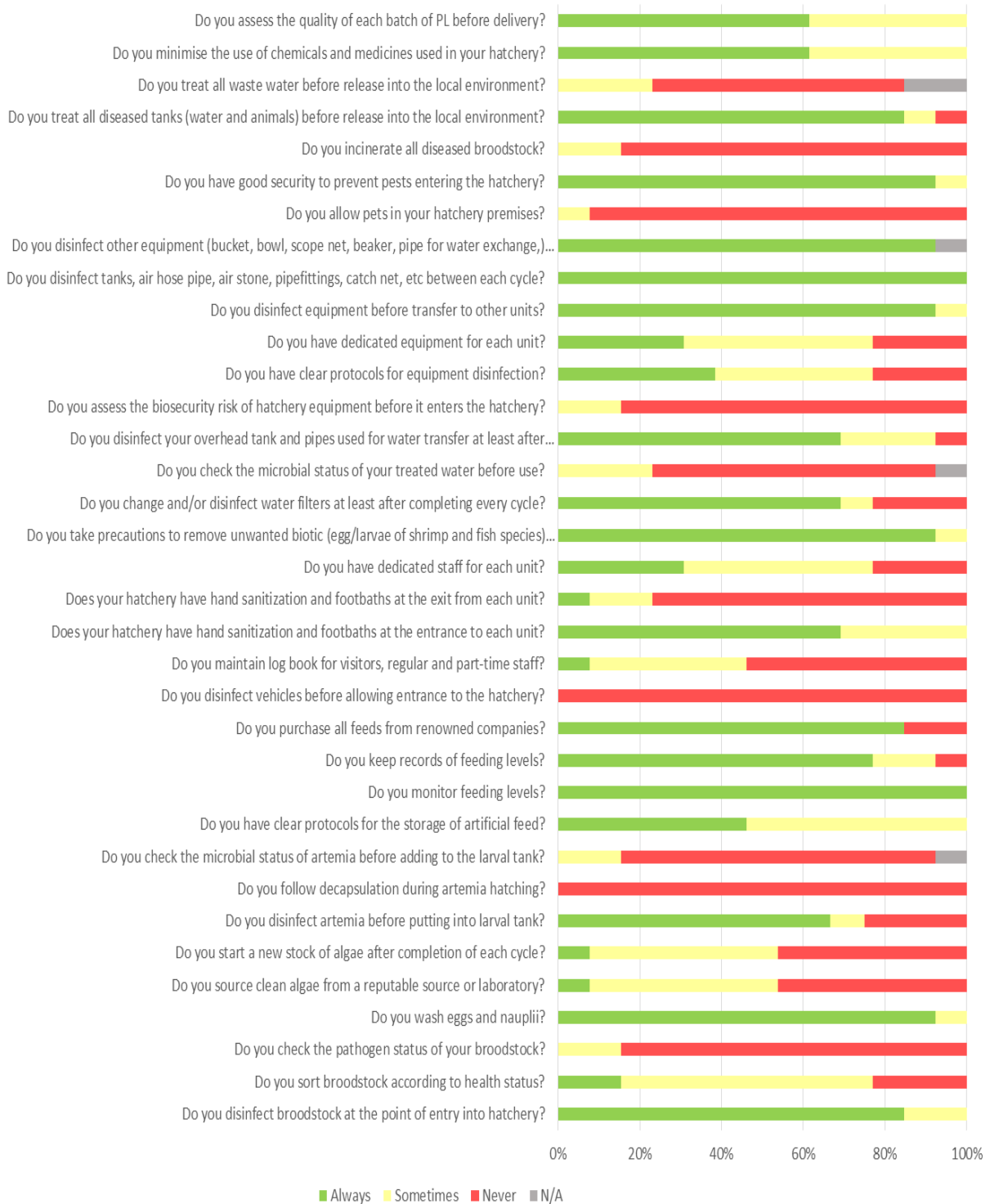


Participants were given these options. For analysis: highest ranking = 5 points, lowest = 1 point. Total points shown. Others (1) = Mismanagement.

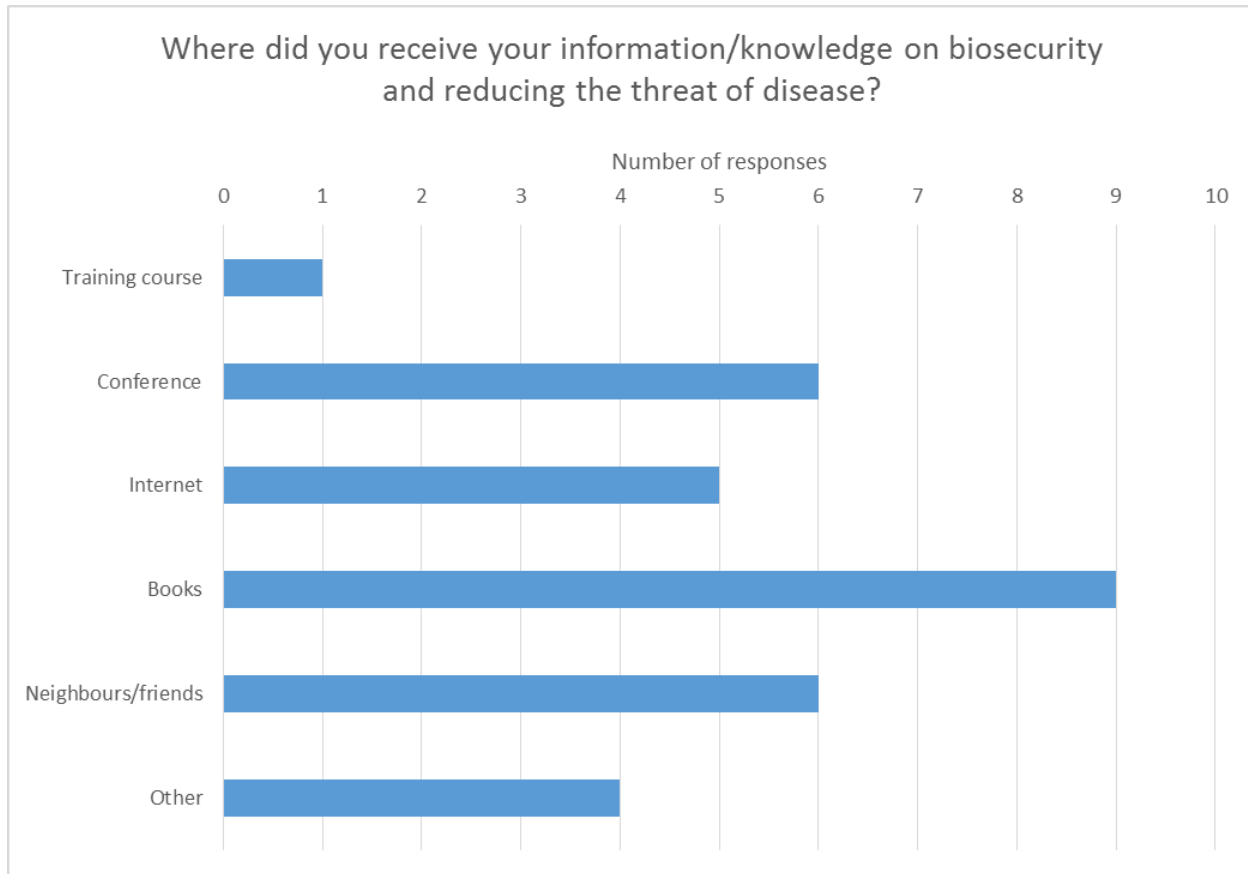


Open question: participants just given categories (resources, facilities, skills/training)

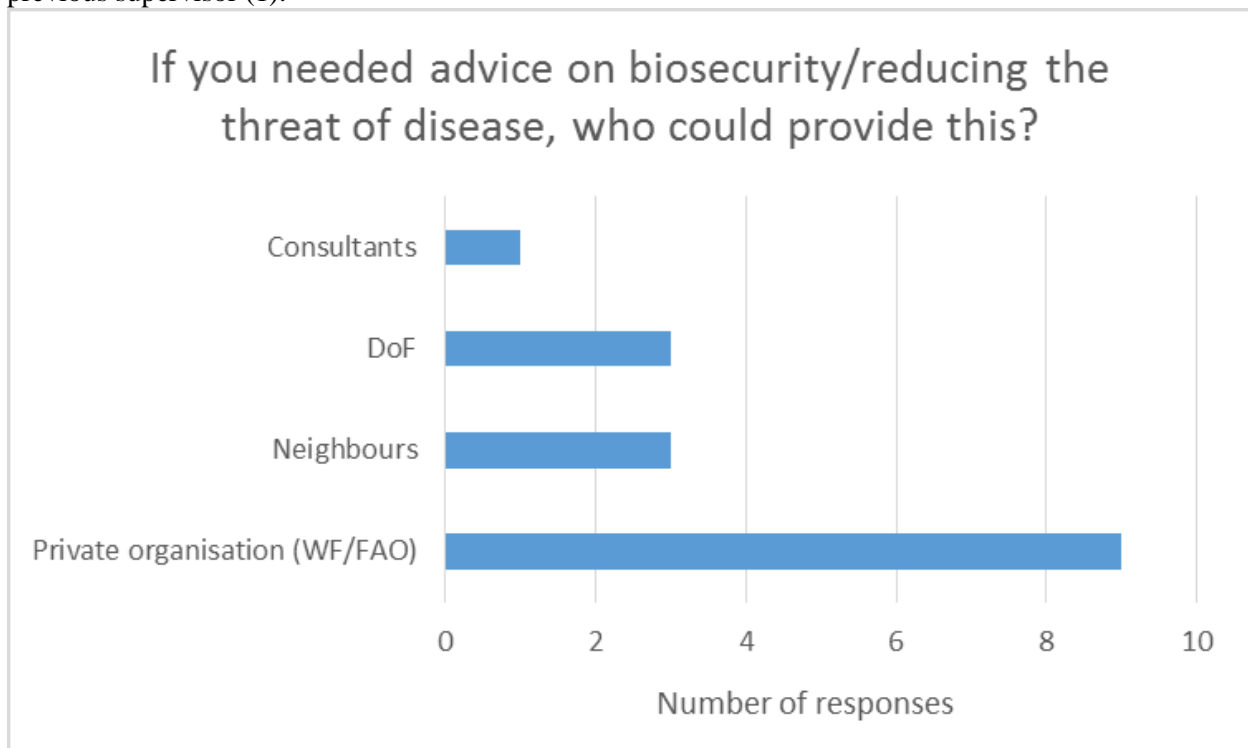
Biosecurity practices



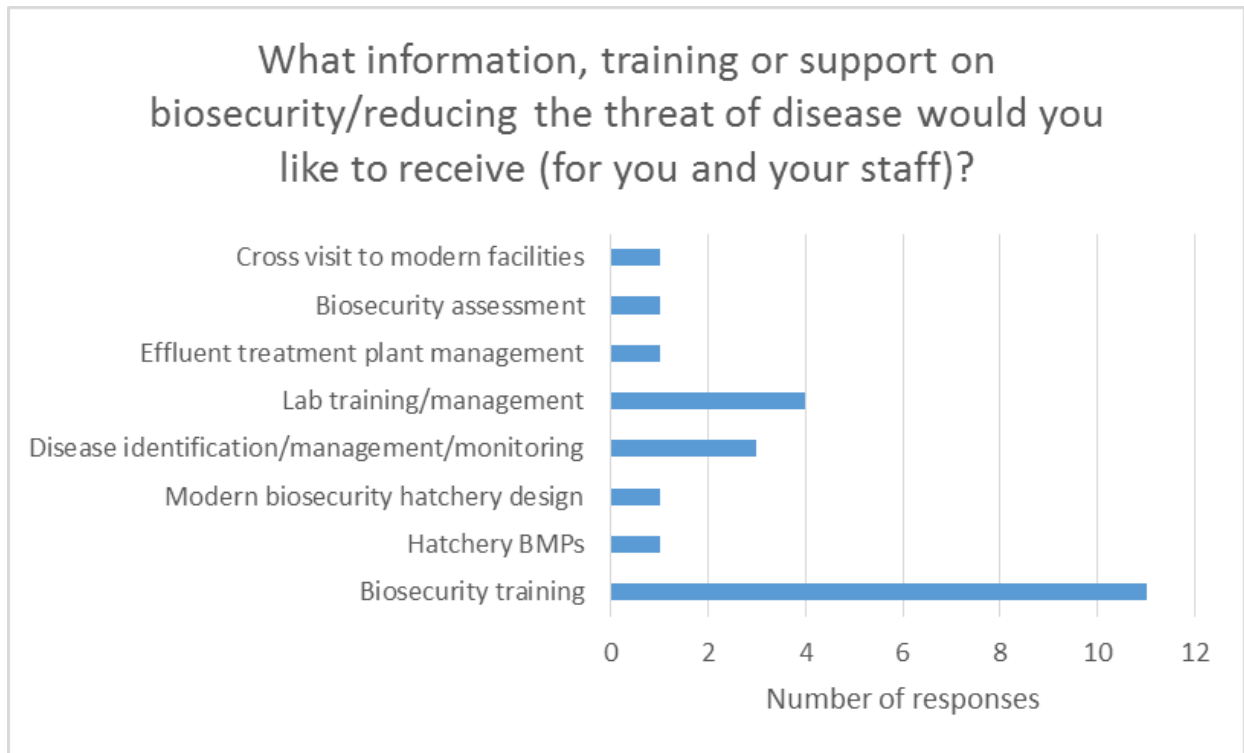
The following data is shown per participant (i.e. 11 participants in total)



Participants were given these options. Others (4 responses) = consultant (1), own experience (2), previous supervisor (1).



Open question. 10/11 participants said that they had sought advice in the past.



Open question.